Technical Report 1154

Interactivity, Communication, and Trust: Further Studies of Leadership in the Electronic Age

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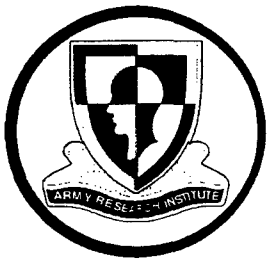
University of Arizona

March 2005



United States Army Research Institute
for the Behavioral and Social Sciences

U.S. Army Research Institute for the Behavioral and Social Sciences

A Directorate of the Department of the Army Deputy Chief of Staff, G1

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REPORT DOCUMENTATION PAGE

1. REPORT DATE (dd-mm-yy)	2. REPORT TYPE	3. DATES COVERED (from. . . to)
March 2005	Final	September 2000 – March 2004

4. TITLE AND SUBTITLE	5a. CONTRACT OR GRANT NUMBER
Interactivity, Communication, and Trust: Further Studies of Leadership in the Electronic Age	DASW01-00-K-0015
	5b. PROGRAM ELEMENT NUMBER 611102
6. AUTHOR(S) Judee K. Burgoon, Suzanne Weisband , and Joseph Bonito (University of Arizona)	5c. PROJECT NUMBER B74F
	5d. TASK NUMBER 1904
	5e. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
Center for the Management of Information McClelland Hall Eller College of Business and Public Administration University of Arizona Tucson, AZ 85721	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. MONITOR ACRONYM ARI
U. S. Army Research Institute for the Behavioral & Social Sciences 2511 Jefferson Davis Highway Arlington, VA 22202-3926	11. MONITOR REPORT NUMBER Technical Report 1154

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES
Contracting Officer's Representative: Paul Gade. Subject matter POC: J. Burgoon

14. ABSTRACT *(Maximum 200 words)*:
Successful leadership and team performance are built on a foundation of trust and effective communication between and among leaders and team members. A broad range of new communication technologies, now ubiquitous in today's military, allow leaders and their teams to work remotely from one another. Our current research program, consisting of 11 laboratory and field experiments, seeks to answer the question of how these technologies affect leaders' ability to foster high trust, morale, and performance with their team by testing the *principle of interactivity:* whether messages sent and received are coherently and tightly linked, create coordinated communication, and are marked by involvement, mutuality (sense of connection, receptivity, common ground, mutual understanding), and individuation (clear and detailed knowledge of sender and receiver identities). Proximal, real-time, and multi-sensory message exchange technologies promote interactivity. We have continued to investigate which forms of electronic communication help or hinder interactivity, as well as whether task load—the degree to which a task is cognitively and/or physically effortful and demanding— alters interactivity and trust. Our results offer best communication practices that will help leaders maximize trust when needed, dampen interactivity and trust when skepticism is needed, and prevent unintended negative consequences when using electronic media.

15. SUBJECT TERMS
Communication, trust, leadership, interactivity, computer-mediated communication

SECURITY CLASSIFICATION OF			19. LIMITATION OF ABSTRACT	20. NUMBER OF PAGES	21. RESPONSIBLE PERSON
16. REPORT	17. ABSTRACT	18. THIS PAGE			
Unclassified	Unclassified	Unclassified	Unclassified	82	Ellen Kinzer Technical Publication Specialist 703-602-8047

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Interactivity, Communication, and Trust: Further Studies of Leadership in the Electronic Age

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March 2005

Army Project Number
2O161102B74F

Personnel Performance, and Training

FOREWORD

The research summarized in this report represents over a decade of research, supported by the U.S. Army Research Institute for the Behavioral and Social Sciences Research and Advanced Concepts Office (RACO) and other federal agencies, investigating leadership and communication at the cyber frontier. The landscape of modern organizations is being transformed by the rapid diffusion of new communication and information technologies and the accompanying reliance on virtual teams. The military's ability to achieve successful leadership at a distance in this new matrix of command, control, communication, and computer systems places a premium on understanding how the design, selection, and use of rapidly changing technologies affects the creation and maintenance of trust. The experimental and field research completed at the University of Arizona offers important insights into how features of these technologies affect communication processes and trust, especially as they promote or inhibit interactivity among team members. Emerging from this work are both a theoretical perspective on the importance of interactivity to achieving team objectives and a protocol for recommended selection and use of communication and information technologies.

MICHELLE SAMS
Technical Director

ACKNOWLEDGMENTS

This research would not have been possible without the support, both tangible and intangible, of Dr. Michael Drillings, our original Contracting Officer's Representative and his successor, Dr. Paul Gade. We are deeply grateful for the collegial and astute guidance we received throughout our exploration of this exciting frontier and for RACO's willingness to permit detours in unanticipated directions. We are hopeful that these directions have yielded unforeseen and beneficial returns. We also wish to express our gratitude for the cooperation and assistance we have received from the Center for the Management of Information at the University of Arizona, and the invaluable contributions of our research assistants, Karl Wiers, Gates Mathew Stoner, Jeff Keippel, Fulin Zhou, and Aaron Bacue, whose industriousness, dedication, and insights greatly advanced the progress of this research program. Were it not for their efforts, the many papers and publications emanating from this project would have been far less. We are hopeful that the knowledge and insight summarized in this report, and in the papers and publications listed in Appendix I, will prove beneficial to the academic community as well as the military.

INTERACTIVITY, COMMUNICATION, AND TRUST: FURTHER STUDIES OF LEADERSHIP IN THE ELECTRONIC AGE

EXECUTIVE SUMMARY

Successful leadership and team performance are built on a foundation of trust and effective communication between and among leaders and team members. A broad range of new communication and information systems (CISs), now ubiquitous in today's military, allow leaders and their teams to work remotely from one another. These technologies are a double-edged sword. The savings in time and cost that they afford may be offset by losses in trust and effective communication. The breathless pace of operations in today's military poses challenges for decision-makers whose ability to sift, digest, synthesize, and transform such information and communication into knowledge, sound decisions, and productive action is severely taxed. Those challenges are magnified by the difficulties of coordinating and managing at a distance.
The Center for the Management of Information (CMI) at the University of Arizona, has been working with the U. S. Army Research Institute's Research and Advanced Concepts Office for the past decade to determine how new CISs affect leaders' ability to foster high trust, morale and performance with their teams. We have concentrated on testing the *principle of interactivity*: whether electronic messages sent and received are coherently and tightly linked, create coordinated communication, and are marked by involvement, mutuality (sense of connection, receptivity, common ground, mutual understanding), and individuation (clear and detailed knowledge of sender and receiver identities). Proximal, real-time, and multi-sensory message exchange technologies promote interactivity. Other technologies inhibit or prevent interactivity.

Results of First Wave of Research

The preceding contract and the current one considered various properties of CISs for their impact on interactivity and resultant trust and team performance. Specifically, it examined mediation (whether communication involves an electronic CIS or not), propinquity (whether team members and/or leaders are in the same locale or geographically dispersed), participation (whether those making judgments of trust and credibility are active parties to the communication or observers of it), media richness (whether communication is text-only or adds other information modalities such as audio and video), and synchronicity (whether interactions occur in real-time or have time lags between messages).
The first wave of research produced the following conclusions:

1. *Participation increases interactivity and trust.* Participants feel more involvement, sense of connection, common ground, and trust than observers; nonparticipation and one-way communication create detachment and possible suspicion but do not limit influence. Greater interactivity and trust are beneficial when there is no reason to doubt the information coming from another team member. In fact, they provide the foundation for better team performance. However, when the goal is detecting invalid and misleading information, nonparticipative CISs which inhibit feelings of connection and similarity and which preclude coordinated two-way conversation should be employed. Leaders can still exert influence under one-way communication and when team members are passive recipients of messages rather than active parties to a dialogue.

2. *Use of electronic communication per se is not detrimental.* What matters are the particular properties of the CIS under use. Team members who use electronic meeting systems in a face-to-face environment, for example, do not suffer losses in task-related credibility or performance relative to those who conduct

a task in an unmediated fashion. Electronic communication may also be more efficient for completion of simple tasks, so mediation in itself should not be seen as problematic. However, it is less advisable for fostering collaboration, coordination, and relationship-building.

3. *Proximity encourages involvement, mutuality, coordination and trust.* Interacting at a distance harms interactivity, trust and credibility. Leaders must be aware of this danger and work to compensate for it.

4. *Modality richness needs to be matched to communication and task objectives.* Face-to-face (FtF) interaction (the richest modality) is well-suited to social purposes (e.g, building relationships and trust) but unnecessary for task-oriented ones. Both audio-only and proximal text CISs, which are "leaner" media, exceed full audiovisual communication in terms of interactivity and/or decision quality. Audio is particularly desirable for coordination, connectedness, and comprehension as long as the number of team members remains small. Proximal text offers the benefits of a division of labor and a permanent record of the messages exchanged. The least desirable CIS, and one in most frequent use at present, is distributed text (e.g., E-mail). It risks the most loss in terms of quality of communication, involvement, mutuality, coordination, and trust. This CIS most requires monitoring by leaders for any such losses and developing interventions to compensate for them where they adversely affect team performance. That said, results from our longitudinal study indicate that team members are capable of creating mutuality, involvement, and trust over time, regardless of the CIS in use. This speaks to humans' ability to adapt to technology when motivated to do so. Leaders can perform a critical role in bolstering such motivation.

5. *Synchronicity matters.* Real-time communication is superior for attaining the kind of positively valenced interaction so essential to establishing strong social relationships, as well as for creating a climate that promotes greater long-term solidarity and commitment to the team and its objectives. Conversely, use of the asynchronous option risks losses on the social dimension. Moreover, the asynchronous format requires significant efforts to coordinate interaction and is the most difficult to adapt to over time. Therefore, leaders faced with using distributed forms of communication should, wherever possible, do so in same-time rather than delayed-time mode (unless the task calls for thoughtful deliberation and skepticism) and take active measures to deter reductions in mutuality and involvement.

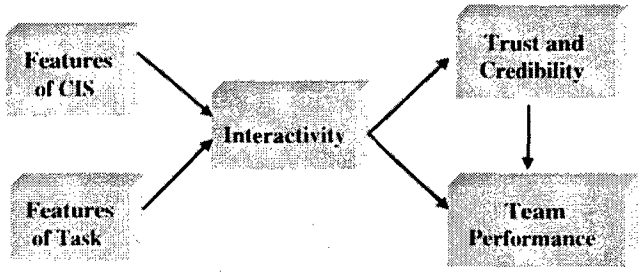
Objectives of Current Wave of Research

The second wave of research addressed these objectives:

- How do as-yet-unstudied properties of CISs affect interactivity, trust, and team performance?
- How do various aspects of *task load* (e.g., time pressure, task complexity, mental effort) alter these relationships?
- When should leaders select CISs that are high in interactivity and when should they select ones that are low in interactivity?
- How should leaders be trained to best facilitate team performance?
- What tools and practices can leaders implement to maximize trust, when trust is the desired goal; to inhibit undue trust, when skepticism or thoughtful deliberation is the goal; and to mitigate unintended negative consequences of using electronic media?

Task load was added to the theoretical model under test. Task load refers to circumstances where informational, physical, cognitive, and/or communicative demands of a situation or task exceed the capacity to perform them effectively or efficiently. Situations in which degree of task load is likely to be

relevant are ones that require ingenuity, mindfulness, and judgmental processes (rather than routine information transmission); that have restricted channels for information transmission; and that entail a serious time-press. Too much or too little stress is thought to be detrimental to performance, but a moderate level of task load may actually be beneficial for optimal performance. How task load alters the relationships among CISs, interactivity, trust, and team performance was tested in the next wave of research. The specific model being tested was as follows:



The second wave of nine laboratory experiments manipulated various forms of task load and features of CISs (propinquity, synchronicity, modality richness) while team members conducted tasks. Two field experiments complemented these studies by providing a theoretical and descriptive explanation of what leaders in virtual teams do to produce collective knowledge and maintain trust so as to accomplish the team's mission effectively and on time. Given the compressed time in which army units must gather information and carry out their tasks, we were especially interested in teams' ability to detect critical information in a pool of irrelevant and inauthentic messages. Further, this research tested the effect of early trust-building in FtF and electronic contexts to determine how initial levels of trust affect the over-time communication patterns and ability to develop trust when teams are no longer physically co-located. Finally, we tested various strategies whereby leaders can improve performance in distant teams communicating electronically.

Results from Current Wave of Research

Experiment 1: Time pressure as task load. The first experiment examined the separate and combined effects of time pressure and modality richness. Team members conducted a series of business case studies while communicating FtF, via audioconferencing, or via videoconferencing and under low, moderate, or high time pressure. Audio communication was found to be the most involving, appropriate, and positively toned of the three. It provided richer, yet more efficient, task-focused, and analytical information exchange than video communication, and rated highest among the three CISs on task discussion effectiveness. Along with FtF interaction, it created better interaction coordination. Greater time pressure improved coordination but it reduced the amount of information and analysis exchanged and degraded decision-making effectiveness, especially under audio. Moderate time pressure was optimal for keeping tension in check. Trust did not differ across modalities or levels of time pressure.

The implications for leaders are that (a) leaders may derive many benefits from using cell phone and teleconferencing forms of communication rather than broader bandwidth modalities but (b) should expect process and performance losses if time pressure becomes excessive; (c) time pressure needs to be kept in

a moderate range, and (d) high-pressure circumstances may require addition of visual cues to coordinate task performance and gain feedback.

Experiment 2: Effects of faulty information as task load. The second experiment investigated the separate and combined effects of modality richness and introduction of faulty information as a form of cognitive task load. Team members discussed four topics intended to promote personal communication while communicating FtF or via one of three CIS modalities (text, audio, or AV). One team member was enlisted to present false, ambiguous, and misleading responses to determine if naive team members would detect the deceptions. Modality effects were such that FtF interaction created the most involvement and mutuality, followed by AV then audio and, lastly, text. Involvement and mutuality increased over time in all modalities except text. Task load in the form of faulty information also adversely affected involvement and mutuality, and those effects persisted over time. Wherever involvement and mutuality suffered, so did trust and credibility. Task load also directly affected trust and truth estimates. Higher accuracy was obtained in the audio and AV conditions, and trust was much lower in the high-load (deceptive information) than low-load condition. By contrast, detection of faulty information was worst in the text modality.

Implications for leaders are that interactivity is key to achieving team morale and cohesiveness. Mediated forms of communication are worse at fostering it than FtF interaction; text is the worst. When using text in situations where trust and credibility are wanted, leaders must compensate for reductions in involvement and mutuality. Where skepticism is wanted, accurate detection of faulty information is best achieved not by text, but by audio and perhaps AV modalities.

Experiment 3: Replication of effects of faulty information as task load. The previous experiment crossing presence or absence of intentionally faulty information with four modalities was replicated, but with the Desert Survival Problem as the task. Team members rated their communication and each other's credibility. Scores were calculated for decision quality, based on deviations from expert rankings, and amount of influence exerted by the confederate team member. This time, modality did not affect interactivity or outcomes but task load did. Higher load (presence of deceptive information) significantly reduced involvement and mutuality, eroded trust, adversely affected other credibility assessments, and resulted in lower quality decisions. Lower involvement and trust also were associated with poorer decisions in the high load (i.e., deceptive) condition.

Implications for leaders are that communication processes "register" invalid information. Reductions in interactivity and trust may be symptomatic of faulty information or ulterior motives present in the team. A conundrum for leaders is whether to opt for less interactivity, in hopes of increasing mindful information processing, or more interactivity, in hopes of decisions benefiting from greater mental and communicative engagement. Because reductions in interactivity and trust did not translate into better critical thinking, strategies are needed to ensure that reductions in involvement and mutuality do not simply dampen alertness, careful evaluation of relevant information, and commitment to the team. Leaders must be on the look-out for these potentially unintended consequences and prepared to take corrective actions to mitigate them.

Experiment 4: Effects of information complexity as task load. Teams worked on the previously described Desert Survival Problem, but with task load now manipulated as either high or low information complexity. In the high complexity condition, the background information document was written at a college level and contained highly technical details taken from a military field manual; in the low complexity information, the document was less detailed and written at a high school level. Four modalities were again used. Results showed that involvement, mutuality, and some facets of credibility were higher under FtF, AV, and audio than under text communication. Trust did not differ across

modalities, but was higher in the high-complexity condition, perhaps because the more technical information conferred expertise and believability. Task discussion effectiveness was rated highest in the audio/low task load condition. Audio and FtF communication were highly regarded and expected forms of communication; the AV format was positively regarded but unexpected; text was poorly regarded and expected.

Implications for leaders are that (a) complex information need not be experienced as overly taxing; (b) text remains the least desired means of communication; (c) FtF and CISs that include nonverbal cues are best for eliciting interactivity; (d) the benefits of audio communication may be limited to circumstances where information complexity is not overly high.

Experiment 5: Effects of synchronicity and faulty information as task load. This experiment entailed students conducting the Desert Survival Problem under synchronous or asynchronous text communication and with one team member intentionally introducing faulty information (high load) or not (low load). Chat was used for same-time communication; an electronic message board was used for different-time communication. As with previous experiments, same-time communication promoted greater interactivity, which was associated with higher trust and credibility. Synchronicity also led to higher quality decisions. Contrary to expectations, presence of deceptive information did not adversely affect interactivity or credibility but did undermine decision-making. Deceivers succeeded in appearing credible and influencing teammates to make poorer decisions.

Implications for leaders are that (a) same-time communication is far preferable to delayed communication for generating involvement, mutuality, and credibility and (b) communicating in real time can offset otherwise undesirable effects of text-based communication. An important caveat to text-based communication is that it is susceptible to manipulation by the unscrupulous. Deceivers can appear very credible and can jeopardize decision-making with text. This is another argument against overreliance on text-based communication for military teams.

Experiments 6, 7, and 8: Effects of modality and information validity as task load. The next three experiments each utilized a C3ISR (Command, Control, Communication, Intelligence, Surveillance, Reconnaissance) game to test the combined effects of modality and information validity on interactivity, communication processes, and task outcomes. ScudHunt, BunkerBuster, and StrikeCom are variants of an online, turn-based strategy game, the objective of which is for three- or four-person teams to find and destroy enemy weapons hidden on a game board. The task was conducted under text, audio, or FtF communication during which one team member introduced faulty information. ScudHunt became a pilot test for the latter two games, which improved upon many features of the software and the task. With BunkerBuster and StrikeCom, text produced lower interactivity than audio or FtF. It also elicited less analysis and feedback, more guarded communication, less positivity, and less composure, especially under deception. Task load affected trust and team performance. As with previous investigations, participants felt less trust for the source of faulty information, and faulty information impaired task performance. Performance under text differed less between high and low task load than in the FtF and audio conditions, indicating the latter two modalities were more susceptible to damaging impact from deception.

Implications for leaders are that richer modalities foster greater interactivity, high-quality communication, and trust than text does. But the higher interactivity may also be detrimental to team performance. When task load is elevated due to the presence of faulty information to be detected, the most interactive modes are also the ones showing the greatest decrements in performance. The audio mode may also be less advisable when task load is exacerbated by features such as size of the team or

complexity of the task. Under such circumstances, text communication may be easier to manage and offers a permanent record that can be reviewed.

Experiment 9: Effects of information validity, modality, and induced distrust as task load. ROTC cadets played a version of StrikeCOM that mimicked the intelligence gathering needed to develop an air tasking order and subsequent air strike on three military targets. Cadets were assigned a role (naïve, suspicious, deceptive) and interacted under real-time text chat without deception (the control group), real-time text chat with deception, or FtF communication with deception. As expected, the text modality added to task load. Text communication was perceived as more difficult. The task was also perceived as more difficult, and team performance suffered when invalid information was present than when it was not. Team members were more suspicious and motivated to detect deceit when deception was actually present, indicating that they were picking up on some leaked indicators of deceit. Suspicion and motivation were also higher in the text than the FtF mode, possibly due to lowered truth bias and trust. Where suspicion was higher, performance was lower, indicating that greater suspicion did not aid performance.

Implications for leaders are that the presence of invalid information may be recognized implicitly by team members, but its effect may be to damage team relationships rather than to improve team performance. Heightened suspiciousness is insufficient alone to lead to more critical analysis of information and better performance. Leadership is extremely important to harness elevated distrust and channel it toward better analysis of information, rather than let it sabotage team morale and engagement. This is particularly challenging when communication takes place at a distance and over text modes. Team members find such communication far more difficult than FtF communication. Effective leaders must continually monitor team communication for erosion in quality communication and for signs that questionable information is being exchanged.

Experiment 10: Maintaining awareness in distributed team collaborations. Business students in two geographically distant U.S. universities participated in a four-week project to write a policy document using a web-based computer conferencing and E-mail system. Each team had one graduate student as a leader. Results showed that teams whose members sent messages indicating where they were and what they were doing, and messages in which they queried others of their whereabouts, availability, and progress, performed better than teams who did not. Teams were also more successful if they interacted frequently, especially early in the project; shared personalizing information that enabled members to know each others' preferences, work styles, schedules and habits; and maintained nearly synchronous same-time interaction as the project neared its completion.

Implications for leaders are that they can mitigate some of the disadvantages of communicating at a distance by maintaining group awareness through initiating pressure to keep on task and by showing awareness of individual identities, whereabouts, schedules, and preferences. Pressure initiations are most effective when begun early; introducing them late in a decision-making process is counterproductive. Positive and mutually reinforcing cycles of initiations and responses among interdependent team members will contribute significantly to collective trust and cooperation.

Experiment 11: Leadership, modality, and performance in distributed teams. Distributed student teams conducted a four-week project conducted via electronic communication only. Prior to commencing the task, they completed get-acquainted activities either FtF, via the conferencing system that would be used or individually (without interaction), with answers distributed by the instructor. Compared to teams with assigned leaders, team-selected leaders performed better, especially when teams first met online. This could be due to the fact that the web was the medium that the teams would be working with, or it could be that the leaner medium of the web allowed members to focus on appropriate social and task cues. Teams who selected their leaders also used more awareness mechanisms.

Implications for military leaders are that they can gain some of the same benefits achieved by team-selected leaders if they ensure regular and consistent communication among team members. Team performance will also benefit if leaders initiate awareness messages that take note of where people are, what their activities and schedules are, and other individuating information. These kinds of communication are part and parcel of the involvement and mutuality associated with interactivity.

The Principle of Interactivity Revisited

After nearly a decade of research, our conceptualization of interactivity has evolved and undergone refinement. At its most basic level, interactivity refers to interdependent message exchange. But the term has been applied both to systems or tools that structurally enable interactivity and to the communicative and information exchange processes that occur with such Communication Information Systems (CISs). Our theoretical approach has been to disentangle the constellation of structural properties that afford or affect interactivity and the functional qualities of interaction itself that are indicative of interactivity. We have developed a comprehensive conceptual model of the structural "affordances" of CISs that are intrinsic to interactivity and additional affordances that may facilitate or inhibit interactivity.
The structural affordances that we regard as most closely aligned with interactivity include:

- contingency (the capacity to create interdependent messages that linked or threaded with one another versus being unrelated)
- participation (the capacity for users to be active producers and recipients of messages rather than being passive observers or producing nonreciprocated messages)
- transformation (the capacity for feedback and messages that are dynamically co-constructed and altered by participants)
- synchronicity (the capacity to exchange messages in real-time rather than with time lags between transmissions)

Additional CIS affordances that may moderate interactive communication processes and outcomes include:

- mediation (presence or absence of an electronic medium for transmitting messages)
- propinquity (co-located versus geographically dispersed)
- modality richness (number of channels available for transmitting information and amount of context social information available)
- identification (capacity for users to interact anonymously versus with known identities)
- anthropomorphism (degree to which the interface has humanlike qualities)
- concurrency (capacity to send and receive messages in parallel rather than serially)
- reproducibility (capacity to recover and reexamine record of messages transmitted)

These various structural affordances are ones we have been testing systematically and ones we believe are responsible for many of the observed communication processes and outcomes in studies of new media and virtual teaming. These are the structural features to which effective leaders must attend.

These structural properties may sometimes exert influence directly on team outcomes but more often exert their influence through the communication processes they facilitate or inhibit, in particular the amount of interactivity that is enabled. Qualities of communication that we believe are intrinsic to the concept of interactivity are:

- involvement (cognitive, behavioral, and affective engagement in communication and tasks)
- mutuality (psychological feelings of connectedness, similarity, receptivity, understanding, and solidarity)
- individuation (well-defined impressions of other team members)
- coordination (behavioral meshing and synchrony within single interactions and contingent and coherent communication with situational awareness across interactions)

Other related communication qualities that may be associated with interaction include:

- quantity and quality of information exchange (e.g., amount of analysis and evaluation, amount of detail and specificity of information)
- efficiency (amount of information exchanged per unit of time)
- spontaneity (unguardedness) of interaction
- positivity (pleasantness, appropriateness)
- expectedness or novelty of communication
- dominance and influence exerted
- effortfulness (amount of stress, fatigue, difficulty, tension, frustration, or cognitive taxation)

Summary and Implications

Our current research program of 11 laboratory and field experiments sought to provide more definitive answers to which forms of electronic communication help or hinder interactivity, as well as whether task load—the degree to which a task is cognitively and/or physically effortful and demanding— alters interactivity, trust, and team performance. Our results offer best communication practices and guidelines that will help leaders maximize trust when needed, dampen interactivity and trust when skepticism is needed, and prevent unintended negative consequences when using electronic media.

Our laboratory and field experiments have shown us that work teams communicating through new computer technologies fare no worse (or perhaps no better) than teams that hold face-to-face meetings—it all depends on what the task is and what the team's objectives are. Our series of studies focusing primarily on voice-only, audio-visual, and text interfaces, and on several collaborative tasks, found that the degree of interactivity that team members achieve affects team trust and performance, irrespective of the type or difficulty of the task. Collaborations that are perceived as highly interactive reflect favorably

upon perceptions of the participants and are associated with other positive communication qualities such as high quantity of information, efficiency, critical analysis, and smooth, relaxed and pleasant interaction. These qualities, in turn, contribute to strong team performance. Some technologies make high interactivity more likely than others and result in higher team trust and performance. Same-time voice communication is often at least on a par with FtF interaction in creating mutual feelings of connection, understanding, involvement, and coordination, and both are superior to text. Like FtF communication, audio formats often create the conditions for richer and more fruitful discussions, trust-building, and strong team performance. More cognitively challenging tasks may benefit from the availability of visual as well as auditory channels to clarify meanings, signal understanding, and exchange feedback. But even interfaces that are leaner (e.g., text chat) and less interactive (e.g., E-mail) and can still elicit involvement, and be perceived as fairly interactive, under the right conditions and with the right guidance from leaders.

Not all tasks profit from interactivity, especially when longer, more thoughtful deliberation is needed, or potentially invalid information that needs greater scrutiny is being exchanged. In these cases, less interactivity—greater detachment and sense of separation—will lower trust but may result in better decision-making. Real-time technologies such as instant messaging, cell phones and voice communication may actually create mindless information processing and hasty decisions as compared to older technologies such as different-time bulletin boards and text exchanges.

Our research did reveal, somewhat unexpectedly, that the degree of mental or physical effort required for a task has variable effects on communication, trust and performance. People are often able to compensate for task difficulties. For some aspects of communication, moderate difficulty is preferable to low difficulty, probably because it keeps people more alert and caught up in the task. But some interfaces, such as text, which requires typing rather than speaking, require more mental effort to use and therefore may be best matched with less "taxing" tasks. With difficult tasks such as comprehending more complex information, text-based interfaces also seem less interactive, making them inadvisable choices if trust and group morale are at stake. Face-to-face and visual communication, however, are not the best choices if the task entails recognizing and assessing invalid information.

How are these results informative for military applications? The answer depends to some extent on which outcomes are desired. Imagine that one wanted incoming information to be monitored for its veracity—in such cases, audio communication seems to accomplish this, as long as the task is not overly complex, or entails time, pressure, or is among a large number of people. On the other hand, if what is wanted is simple information exchange (e.g., orders or commands that should not be questioned), then chat-style text might fit the bill. In the end, the complexity of communication is affected by the technology that teams use. It is critical that technologies be fitted to desired aims and outcomes and that leaders either select appropriate technologies or take measures to offset any downside risks of using a given technology.

Informal leadership that emerges within a team, rather than formal leadership, may have the most influence on the resultant communication process and outcomes. Designated leaders are well-advised to monitor such interactions, to encourage frequent interactions among distributed team members, and to initiate messages that promote group awareness. Attentiveness to the general effects of interactivity should be a central criterion in selecting and utilizing electronic communication in today's army.

INTERACTIVITY, COMMUNICATION, AND TRUST: FURTHER STUDIES OF LEADERSHIP IN THE ELECTRONIC AGE

CONTENTS

THE CHALLENGE OF LEADERSHIP IN THE ELECTRONIC AGE

Today's leaders in the armed forces face a largesse of information and technologies that are a double-edged sword. The ease and rapidity of information creation, rendering, and distribution via the Internet; the avalanche of information and messages exchanged; the constant access, even surveillance, wrought by the pervasiveness of e-mail; and the numerous interruptions created by computer-based technology not only are contributing to "overload" in the military but in all modern organizations. As part of the military's command, control, communication, and computer systems infosphere, new communication and information technologies (CISs for short) inevitably invite accelerating reliance on them because of the savings in time and cost that they afford. At the same time, they are creating a breathless pace of operations that poses significant challenges for decision-makers, whose ability to sift, digest, synthesize, and transform such information and communication into knowledge, sound decisions, and productive action is severely taxed. Those challenges are magnified by the difficulties of coordinating and managing such largesse at a distance.

One major casualty of the new communication and information order, beyond general increases in stress levels and attendant declines in morale, may be the ability of leaders to establish and maintain the interpersonal trust and credibility so essential to effective team performance. Paradoxically, as distant (virtual) teams become more commonplace, the pervasive reliance on electronically mediated communication may also lead to too much trust for the information and messages that are transmitted and concomitant failure to recognize flawed and invalid data, arguments, and recommendations. Grappling with these issues requires a deeper understanding of how leadership under distributed conditions is affected by the inevitable increased reliance on electronic and computer-based media such as e-mail, cell phones, voice over IP, audio- and videoconferencing, computer-assisted group decision making, and virtual reality. It is these interrelated concerns that motivated this follow-on research.

Our knowledge base to date, as well as the training of future leaders, has been heavily reliant on traditional face-to-face contact. "E-leadership"– accomplishing leadership using electronic media–may require new strategies and new approaches to training. Military teams must be able to work closely together, learn from each other, and accomplish specific goals, all within a compressed period of time and under increasingly autonomous conditions. Unit commanders must be able to execute their orders, or the intent of their orders, with confidence that these self-contained, autonomous units can perform effectively. Such confidence is founded on mutual trust and group cohesion fostered by effective leadership.
In theory, CISs should facilitate the movement and coordination of distributed personnel and material resources. They should enable senior officers far from the battlefield to substitute their judgments for that of ranking military personnel on the scene. The hope is that these technologies will provide quick and effective communication access to division leaders and other officers, and that teams will become increasingly distributed, flexible, and responsive to environmental events. But the full range of payoffs will come only if leaders and team members can build a foundation of interpersonal trust and credibility, only if they can accurately transmit, receive, interpret, and judge the information they exchange, especially when time is constrained. Inattention to communication issues risks not only misuse but also failure to realize the full benefits of these new technologies. Astute leaders must be aware of the possibility of CISs undermining the credibility and trust that is essential to effective communication and performance. They must be aware of the potential for information, messages, actions, and identities that are illusory, distorted, or fabricated.

The challenge for leadership, then, becomes determining what mix of face-to-face and mediated communication formats is most advantageous for achieving which objectives, when, and why. Leaders must decide when and how often newly formed, temporary teams should meet face-to-face versus

electronically. They must be aware of how the messages they construct electronically advance or deter their efforts to gain trust and compliance from subordinates. And, they must recognize when reliance on various media, electronic data sources, or virtual agents might affect performance by diminishing or enhancing their own and others' ability to judge the authenticity of data, information, and messages they receive.

Cast in practical terms, military leaders at all levels must daily choose whether to interact with their subordinates face-to-face or through some electronic means. Inherently, people prefer face-to-face contact. Yet an increasingly common scenario is the formation of virtual teams, consisting of personnel from different locations or across different branches of the military, who are formed to tackle some problem, formulate tactical plans, or make policy. Often they must do so under serious time pressures. By virtue of their geographic separation, these groups must now interact electronically. How is this best handled? What potential problems must be forestalled and how can the technologies best be used to optimize communication and information exchange? What if, as is so often the case, these situations involve time pressure, stress, or information overload? Such questions motivated the current endeavor.

RESEARCH OBJECTIVES

Guiding our approach to the overarching issue of how trust in virtual teams can be developed, sustained, attenuated, or undermined when using new CISs has been *the principle of interactivity.* Simply stated, *communication processes and outcomes vary systematically with the degree of interactivity present in team communication.* This principle, whose theoretical properties we elaborate more fully below, served as the foundation for the series of laboratory and field experiments being reported. Beyond extending the interactivity research conducted under the previous contract, the current contract focused on how various forms of task load alter interactivity, leader credibility, and team performance. As well, it considered how to translate such knowledge into training for more effective leadership. Specific questions addressed were:

- How do as-yet-unstudied properties of CISs affect interactivity, trust, and team performance?
- How do various aspects of *task load* (e.g., time pressure, task complexity, mental effort) alter these relationships?
- When should leaders select CISs that are high in interactivity and when should they select ones that are low in interactivity?
- How should leaders be trained to best facilitate team performance?
- What tools and practices can leaders implement to maximize trust, when trust is the desired goal; to inhibit undue trust, when skepticism or thoughtful deliberation is the goal; and to mitigate unintended negative consequences of using electronic media?

THE PRINCIPLE OF INTERACTIVITY

The research findings to be presented here offer some answers to these very compelling questions, framed through the lens of interactivity. Intuitively, interactivity implies a give-and-take between actors that occurs in real-time. For example, a group discussion described as highly interactive is one in which members are highly engaged in the discussion and very talkative, with members and leaders exchanging turns rapidly and all sharing the conversational floor. Email becomes interactive chat if it allows message recipients or audience members to respond immediately to the messages and information that is

transmitted. Interactive instructional tools are ones in which movements through the lessons are contingent upon the last response.

Interactivity has attracted widely ranging conceptualizations. Our own derives from interpersonal deception theory (Buller & Burgoon, 1996) and efforts to understand how interactive deception differs from noninteractive deception. Our initial analysis considered both structural features of communication systems (referred to as affordances) and the phenomenological experiences of actors (e.g., Burgoon, Bonito, Bengtsson, Ramirez, Dunbar, & Stoner, 1999; Burgoon, Bengtsson, Bonito, Ramirez, & Dunbar, 1999) as forms of interactivity. However, we subsequently concluded that such an approach overloads the construct of interactivity with features that have been associated with it but are not necessarily intrinsic properties of it. What follows is a summary of our revised conceptualization of the principle of interactivity, which undergirded all the studies conducted during the two RACO contracts.

Definitions

At its most fundamental, interactivity in the context of communication refers to interdependent message exchange. Literally, to "interact" is to engage in acts that are interrelated to, rather than independent of, others' actions. Applied to communication, the interdependent acts are verbal and nonverbal messages. Seemingly simple on the surface, interactivity, when analyzed more closely, becomes increasingly nebulous and elusive. The term has been used to reference such diverse phenomena as communication technologies that permit message transmission in real time (e.g., interactive email), simultaneous message transmission (e.g., duplex teleconferencing), expert systems that provide tailored responses to queries (e.g., interactive websites), face-to-face discussions characterized by high levels of participation (e.g., as found with nondirective teaching styles), and research protocols that permit message sender and message target to talk with one another (e.g., interactive deception). Not surprisingly, then, there is little consensus on a definition in the research literature. Different usages imply that interactivity resides in properties of technologies, of messages, of individuals, of interpersonal and group processes, or all of the above.
For purposes of understanding new communication technologies, we have opted for a definition that focuses on properties of interaction itself. By "interaction" we mean time-bound occasions (also called episodes) during which two or more people converse. "Interactivity," by comparison, refers to specific qualities of those episodes. Media affordances strongly influence the extent to which interactivity is present. Hence, we need to briefly summarize what is meant by affordances before considering the impact of interactivity on trust and team performance.

Affordances Associated with Interactivity

Communication affordances are structural features of communication and information systems (CISs) that permit or enable certain kinds of actions but do not compel them in a deterministic fashion. In keeping with the view of actors as agentive rather than reactive, the terminology of "affordances" is intended to stress that the context or format affords but does not require or automatically elicit interactivity. Decades of research on CISs in the workplace have demonstrated significant effects on everything from amount of communication and group morale to task efficiency and effectiveness. Early on, many studies compared face-to-face (FtF) interaction to various forms of computer-mediated communication (CMC) and drew conclusions about the superiority of one over the other. This led to claims that FtF communication is essential for tasks that are complex, require sophisticated inferences and analysis, or depend upon trust and interpersonal solidarity (e.g., Hallowell, 1999; Nohria & Eccles, 1992). But numerous conflicting and nonsignificant findings, coupled with the inevitable increased reliance on distributed forms of communication such as e-mail, fax, and videoconferencing, have necessitated a rethinking of this position. Beyond the improbability that FtF is routinely superior or necessary, the speed, efficiency, breadth of information-sharing, and opportunities for distributed collaborations mean that there will be many circumstances where FtF is not one of the options. Research thus needs to determine which alternatives are preferable for which kinds of tasks and goals and to identify what can be done to adapt systems, people, and communication to achieve the desired outcomes, because some of the most

important aspects of leadership may be impacted. As Straus and McGrath (1994) argued, the impact of the communication mode is more likely to affect group outcomes "when tasks require coordination and timing among members' activities, when one is attempting to persuade others, or when tasks require consensus on issues that are affected by attitudes or values of group members" (p. 89).

Our approach to this issue is guided by the assumption that it is not FtF interaction per se that is wanted but the properties that are inherent to FtF interaction. Put differently, if other CISs offer the same features as FtF, they should produce comparable effects. We also assume that these properties are value-neutral; their presence can be either beneficial or detrimental (see also Ha & James, 1998). For example, text-based interaction might undercut trust because group members are unable to monitor one another's work effectively or it may lead to too much trust and undue influence by computer-delivered information; conversely, it might create more carefully edited discourse or produce more understanding and rapport among participants (Walther, 1996; Walther & Burgoon, 1992; Weisband, Iacono, & Gilliam, 1999). FtF interaction might promote ready acceptance of dubious information or it might facilitate idea generation. Deciding which communication formats!e.g., human-computer interaction, computer-mediated communication, or face-to-face interaction!are most or least advantageous under what circumstances and why depends, then, on understanding what properties differentiates modes of communication and information exchange from one another.

What follows are a range of CIS properties that may influence interactivity and, consequently, leader success in eliciting trust, compliance, and effective team performance. These propertes were derived from our own review of the CMC and interpersonal communication literature (see, e.g., Bengtsson, Burgoon, Cederberg, Bonito, & Lundberg, 1998, 1999; Burgoon et al., 1999; Burgoon, Bengtsson, Bonito, Ramirez, Dunbar, & Miczo, 1999-2000; Burgoon, Bonito, Bengtsson, Cederberg, Lundberg, & Allspach, 2000).

Contingency concerns the extent to which any given actor's verbal and/or nonverbal messages are contingent upon, or interdependent with, those of other actors. Put differently, messages are contingent if one person's communication can plausibly be shown to connect to, to be dependent upon, the behavior of other interlocutors. A CIS affords contingency if it permits an ABA sequence where A represents an initial utterance, query, or behavior that is followed by a response by B and a subsequent response by A, that is, there is the possibility of feedback between A and B. A question that is asked but not answered becomes a noncontingent utterance, whether it occurs in face-to-face interaction, in computer-mediated interaction, or in queries to an expert system. A CIS that does not permit replies, such as automated phone systems that simply make announcements and do not offer callers a menu of options to follow, is noncontingent. CISs that are intended to afford contingency but fail to do so, such as websites with links that fail to connect to other sites, also become inadvertently and unexpectedly noncontingent and noninteractive. Operationally, contingency is demonstrated when one actor's baseline behavior is altered in the presence of another actor, or participants use linguistic coherence mechanisms to create a conversational thread, or actors show emotional and behavioral contagion.

Participation refers to holding a legitimated role in the episode such that one is permitted to take turns at talk, initiate talk, is the target of others' communication, and has tacit obligations to sustain the conversation. It implies interdependence and collaboration between message sender and receiver to construct a tightly interwoven pattern of utterances. Actors who are participants in, rather than observers of, an interchange are interactive. By contrast, observers do not take turns at talk; their thoughts, feelings and behaviors have no direct impact on participants; and they need not be physically present, instead reading, hearing, or viewing recordings/transcripts of the interaction at a later date. Actors who are passive group members (such as in participant-observer research) and those who overhear or eavesdrop on a conversation (such as chatroom lurkers and observers of police interrogations) also qualify as observers. Communication formats and contexts may vary in the degree to which actors are afforded real

opportunities to participate. One-way communication formats such as bulletin boards do not afford participation. among the recipients. Highly directive leaders who dominate the speaking floor place followers primarily in the auditor-observer role. And, team members may opt out of active participation and into a passive stance of a passive observer.

Synchronicity refers to whether interactions take place in real-time or involve a time lag between message transmissions. (It should be noted that "synchronous interaction" is not synonymous with "interactional synchrony" which, in the interpersonal interaction literature, refers to coordinated, tightly meshed, rhythmic interactions, though both concepts share an emphasis on temporal aspects of communication.) Full-duplex VTC permits auditors to transmit nonverbal feedback at the same time as senders are transmitting their verbal and nonverbal messages, producing interaction that more closely approximates face-to-face interaction than older systems in which transmissions were serial. Although synchronicity is usually associated with contingent message exchange, actors can communicate concurrently, i.e., in parallel, and produce totally independent messages, so synchronicity does not guarantee interactivity.

Conversely, many asynchronous CISs have features designed to facilitate the "threading" of such messages so as to increase their coherence and relevance to one another and thus increase interactivity. The reply function of email and the capacity to intersperse replies with parts of the original message are a case in point. Still, greater time intervals between transactions typically weaken the degree of contingency as multiple topics and inquiries are transmitted, only some of which are addressed by respondents, meaning that asynchronous CISs are usually associated with lower interactivity.

Mediation and propinquity, respectively, refer to the interposition of some mechanical or electronic medium by which the message creator transmits messages to recipients and whether interactants are co-located or geographically dispersed. Mediation can be low-tech, such as letter writing and walkie-talkies, or high-tech, such as messages delivered via film, television, or computers. If interlocutors share the same physical environment (e.g., face-to-face group interaction, "co-located" computer-mediated communication), they are proximal or "propinquitous." If they are interacting at a distance, they are "distributed." The distinctions among synchronicity, mediation, and propinquity are subtle but important. Asynchronous systems are mediated and distributed (i.e., employed among team members who are geographically dispersed). Synchronous interactions can be either mediated or unmediated, and either proximal or distant. Synchronicity may be more important than propinquity in influencing interaction. If distributed interaction occurs in real-time, that may mitigate reductions in interactivity due to geographic separation.

Modality richness concerns the extent to which participants have access to a full complement of sensory and information modalities by which to contextualize messages, glean essential social information, exchange relational messages, and coordinate conversation. Compared to FtF interaction, most mediated formats restrict how many of these modalities are available. Video-conferencing, for example, preserves visual, audio, and verbal information but loses spatial, tactile, olfactory and environmental cues; audioconferencing removes all visual information; and further removes auditory information. Because fewer modalities mean fewer channels through which to create tight linkages between actors' messages and behaviors, modality richness can influence interactivity.

Identification refers to the extent to which actors are known to each other or anonymous. Whereas the identities of team members and leaders are known in FtF conversation, text-based interactions enable people to send messages anonymously, to adopt pseudo-identities, or to assume false identities. Because leaner CISs strip away such identifying information as voice or physical appearance, they may in some circumstances attenuate the degree of connection felt by participants while in others, they may free participants to be more forthcoming.

Anthropomorphism refers to the degree of humanlike qualities present in a CIS interface. It is most relevant to human-computer interaction, where avatars and bots may range from ones that strongly resemble humans to ones that have no human-like qualities at all (e.g., Clippie, the Microsoft Office Assistant) and automated voices range from sounding very mechanical and synthesized to very natural-sounding. Like identification, this affordance can have opposing impacts on interactivity.

All the aforementioned properties of CISs are relevant to leadership in the military insofar as they influence the degree of interactive communication that transpires between and among leaders and team members.

Communication Qualities Associated with Interactivity

Interactivity is manifested in qualities of the interaction itself. Those that seem most closely allied with the concept of interactivity are (1) involvement, (2) mutuality, (3) coordination, and (4) individuation, among other qualities.

Involvement, which is both a cognitive and a behavioral variable, refers to the degree of individual cognitive, sensory, visceral, and motor engagement in the conversation or task. It shares a strong kinship with the concepts of physical, social, and telepresence. Physical presence entails heightened awareness of the physical environment and one's own body. Social presence entails users feeling that a form, behavior, or sensory experience indicates the presence of another intelligence. Telepresence refers to the illusion of being transported to another physical "space" via media. Like involvement, these concepts imply a high degree of psychological and physical immersion in the communication environment; rich motoric, sensory, and social inputs and outputs; heightened awareness of other social actors; and mental engagement in the activity at hand. As a behavioral variable, conversational involvement is characterized by frequent talk, high nonverbal immediacy (e.g., close conversational distance, high amount of gaze, forward lean, touch), attentive listening, smooth and synchronized conversation, and moderate relaxation. *Mutuality* refers to the sense of connection, common ground, solidarity, similarity, openness, and understanding that participants perceive and establish between one another. If a prerequisite to effective communication is some sense of relationship among parties, no matter how fledgling, and a co-orientation to one another that forms the foundation for cognitive, affective, and behavioral interdependencies, then mutuality as a constellation of properties captures the extent to which parties to an interaction feel mutually linked. Behaviorally, mutuality is typified by conversational coordination, which may take the form of synchronization and adaptation to one another's verbal and nonverbal behavioral patterns within a given encounter and coordination of communication and activities across encounters. Because coordination is such a key feature of interactivity and swift trust, it often merits special attention separate from the psychological aspects of mutuality.

Individuation refers to the extent to which parties have well-defined impressions of one another rather than vague identities and pseudo- or imagined relationships. Higher interactivity is usually characterized by greater familiarity with, and knowledge about, other interactants. Relationships that are more individuated are marked by private or idiosyncratic language, more restricted and cryptic rather than elaborated language style, familiar terms of address, and informality in nonverbal behaviors.

The communication qualities of involvement, mutuality, coordination, and individuation do not exhaust the properties that are indicative of interactivity but represent some of the more salient indicators of interactive exchanges. Because interactivity is thought to be instrumental in establishing trust and credibility, we turn next to explication of the concept of trust.

LEADERSHIP AND TRUST

Leadership is about influencing others, building consensus on decisions, and securing loyalty and voluntary compliance. Conceptualized this way, effective leadership depends on creating a relationship founded on trust, respect, and credibility. The concept of credibility itself, which can be traced back to Aristotle's concept of ethos, includes such facets as competence (i.e., attributes such as knowledge, intelligence, experience, and authoritativeness) and character (attributes such as trustworthiness, reliability, honesty, and good will) (McCroskey & Young, 1981). Because trust is variously equated with honesty, competence, reliability, dependability, and good will toward others, for purposes of our investigations trust is viewed as synonymous with the broader construct of credibility.

It is axiomatic that a prerequisite to effective work group functioning is the establishment of trust, especially among teams that are geographically dispersed and must accomplish their tasks rapidly (Iacono & Weisband, 1997; Meyerson, Weick, & Kramer, 1996). Because the very concept of social organization relies on reciprocal trust, good will, and cooperation (Gouldner, 1959; Grice, 1989), people are usually inclined to give one another the benefit of the doubt, to view each other as truthful and trustworthy. This "truth bias" is bolstered by the human tendency to regard all incoming information as truthful and, only after digesting and reflecting upon it, to entertain the possibility that it may be false (Gilbert, Krull, & Malone, 1990). Thus, the default orientation of team members and leaders should be toward mutual trust. Nevertheless, trust is not a given. It depends fundamentally on the interpersonal relationship leaders have with peers and subordinates and the history that they share. People are predisposed to trust others whom they know well because they have a basis for assessing each other's expertise, sound judgment, honesty, reliability, poise, and so forth. Early in relationships and among previously unacquainted virtual team members, trust is provisional and probationary, and it is inextricably linked to communication practices.

As regards use of electronic media, the successful leader is one who knows how to select the right CIS for a given task, to manage communication within CISs during team work, and to ward off negative and unintended consequences from improper use of CISs. The research that follows was designed to yield a set of principles for understanding the relationships among communication, trust, and effective leadership and to generate recommendations on what properties of CISs leaders should select, avoid, and/or augment for a given type of task or goal.

The first wave of research considered the impact of key properties of CISs in eliciting interactivity during team work and in influencing team outcomes. Our model of the interrelationships among CISs, interactivity, trust and team performance is reviewed next. We then summarize our initial findings from the first series of investigations before turning to the potential moderating impact of *task load* on those relationships. Because various aspects of increased load have significant implications–some good, some bad--for group process, performance, and trust, we explicate the concept of *task load* and its multiple facets. We then report results from the next nine investigations we conducted before concluding with the applications to, and implications for, leadership in the electronic age.

RELATIONSHIPS AMONG CISs, INTERACTIVITY, TRUST AND TEAM PERFORMANCE

A commonly held view has been that new communication technologies filter out important contextual and social cues and that the resultant impoverished communication environment results in a loss of social presence compared to that available in FtF interaction (e.g., Culnan & Markus, 1987; Krauss & Fussell, 1990; Krauss, Fussell, & Chen, 1995; Rutter, 1987; Short, Williams, & Christie, 1976; Sproull & Kiesler, 1986, 1991). The reduction in presence is thought to have deleterious effects on the development of good working relationships, on the quality of communication, and on task performance unless people are able

to compensate for it somehow. Such views have been the catalyst for substantial engineering efforts to produce "richer" multimodal forms of communication that can simulate the contextual information of FtF interaction. They have also buoyed claims that some degree of FtF interaction must be preserved. In this day of temporary virtual teams and the need to create swift trust, this might seem to place a high premium on maintaining a substantial amount of FtF communication so that leaders and group members can determine how much reliance to place on the knowledge, information, and opinions of others.

However, research evidence has been anything but compelling that modalities per se are the issue or that FtF interaction is a superior mode of communication (see, e.g., Krauss & Fussell, 1990). Moreover, few prognosticators expect computer-mediated communication (CMC) to supplant FtF interaction totally. An alternative view is that FtF is not the inevitable preferred venue for establishing trust; that to the contrary, humans can effectively compensate for structural shortfalls if given adequate time and motivation and may even develop closer relationships electronically (e.g., Walther, 1996a; Walther, Anderson, & Park, 1994; Walther & Burgoon, 1992). The key, according to rational media-choice models and other goal-oriented approaches (e.g., Buller & Burgoon, 1996; Kayany, Wotring, & Forrest, 1996), is in matching communication tasks to media capabilities to meet communicators' goals. For example, when a task entails unambiguous orders or the goal is to be strategically ambiguous, "lean" modalities might be preferable; but such modalities might be dispreferred to nonverbally richer ones for situations that involve complex and stressful tasks, information open to multiple interpretations, or collaborative decisions that depend on solid interpersonal relationships (see, e.g., Contractor & Eisenberg, 1990; Daft, Lengel, & Trevino, 1987; Fulk, Schmitz, & Steinfield, 1990; Fulk, Steinfeld, Schmitz, & Power, 1987; Fussell & Benimoff, 1995; Galegher & Kraut, 1990; Hellerstein, 1985). Communication under time pressure may fit this latter category.

These alternative perspectives draw attention to the need for a deeper understanding of the nature of mediated and unmediated communication between people as a prerequisite to making reasonable use of current technologies (as well as designing new ones). But simple comparisons among communication formats alone will not tell the whole story; we need to examine what essential interpersonal interaction properties are afforded by various communication and information technologies if we are to understand *when, how, and why* leaders should opt for one communication arrangement over another. The principle of interactivity offers a guiding principle for making such decisions. That is, the level of interactivity in any context should account for a large share of the variance in how groups perform and regard one another. It should also account for much of the variance in the effects of new technologies in the workplace.

Put in practical and concrete terms, leaders often control the forms and nature of communication that will occur within teams. For certain tasks, high interactivity is desirable. If our theorizing is correct, tasks that require solidarity, an uninhibited exchange of ideas, sharing of critical information, and willingness to offer criticisms and evaluations warrant highly interactive communication processes–ones marked by high involvement, mutuality, coordination, and individuation. When leaders have choices, they will want to select the forms of communication that best foster interactivity, whether it be face-to-face interaction or a computer-mediated option, or, if team members must work at a distance, they will need to choose among text-based, audio-based, and video-based technologies and among synchronous or asynchronous options. For other tasks, such as making thoughtful and considered decisions without groupthink or group pressure, or when conducting simple information exchange tasks, low interactivity may be the most desirable, which may mean selecting those structural affordances that are most likely to reduce rather than foster interactivity.

Our model of CMC and HCI locates the processual facets of interactivity as a mediator between technology and outcomes. It stands in contrast to many previous models of technology use and adoption that endorse, often implicitly, a form of technological determinism in which features of a medium are

assumed to have fairly stable effects on task and communicative outcomes. However, as noted above, scholars have begun to question this assumption, given research evidence that participants often adapt or adjust their communicative behavior to overcome inherent limitations in technology design (Poole & DeSanctis, 1992; Poole, Holmes, Watson & DeSanctis, 1993; Poole & Holmes, 1995; Walther, 1996). Thus, merely introducing a particular technology, regardless of the quality of its design, into existing communicative practice, is no guarantee that participants will make use of it in ways envisioned by designers. As noted by Postmes, Spears, and Lea (2000), the uses and outcomes of CMC and HCI are affected by existing norms and practice. Participants construct the means by which technology plays a meaningful role in task and relational communication; technology itself does not construct communication and outcomes. A central component of understanding, explaining, and predicting the role of technology in human endeavors is to document and detail communication processes and practice. For example, as Walther's (1996) work clearly demonstrates, building interpersonal relationships presents a series of opportunities and challenges that are largely independent of the medium, and participants incorporate features (or lack of same) of technology into the process of becoming acquainted. Technology does not dictate the terms of relationship building; it merely attenuates or amplifies the means by which people already engage in such practices. And the success with which people develop relationships is not just a function of what any given technology has to offer; it is a consequence of what one is willing to do and accept in the pursuit of establishing friendships and intimacy.

Because the majority of our current research is concerned with the impact of technology on decision-making tasks, and because social influence is an inherent component of decision making, we have drawn on work from persuasion scholars, most notably McGuire (1985), to link structural affordances to outcomes. McGuire argued that one's persuasiveness is a function of the degree to which he or she is judged positively on a variety of social dimensions, including trust, competence, and dominance, among others (Burgoon, Johnson, & Koch, 1998). Credible group members are more likely to be influential. Although there is ample evidence that factors unrelated or tangentially related to communication (e.g., appearance, status, power) affect how people come to be judged positively on relevant social dimensions, we argue that the degree to which one communicates interactively is an important antecedent of social judgments related to influence.

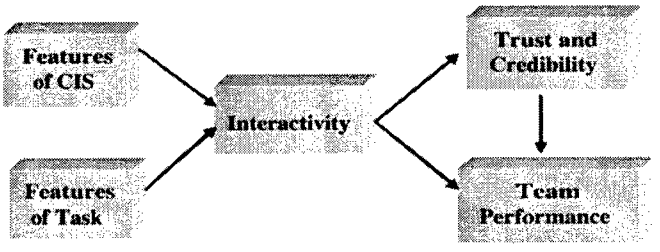


Figure 1. Relationships among CIS Interfaces, Task Features, Interactivity, Trust and Performance

As presented in Figure 1, a given technology's structural affordances influence the degree to which actors behave mutually with one another and are engaged in their interaction and task, and they affect the degree to which the actors sense mutuality and involvement from each other. Involvement and mutuality in turn affect social judgments; interaction that is, and if perceived to be mutual and involved are likely to lead to more positive evaluations on various social judgments. And the degree to which one is perceived to be more competent, trustworthy, dominant, and credible, for example, is consequential for outcomes such as task performance and influence.

SUMMARY OF FIRST WAVE OF RESEARCH

The first wave of experimental research was designed to parse out the separate and collective effects of five CIS affordances--participation, mediation, propinquity, modality richness, and synchronicity--and their correspondent interactional features of involvement and mutuality--on leader trust and credibility, leader influence over subordinates, and task performance. The original proposal called for four experiments. In light of initial findings from pilot work and the first studies, and in light of the continuation contract we were awarded, the original scope of work was modified and expanded to include ten laboratory and field experiments. Laboratory experiments considered how, in the absence of FtF interaction, leaders and work group members establish trust through their communication practices. Field research explored more deeply, and in a quasi-experimental manner with multiple tasks, how distributed temporary teams attempt to simulate or restore properties of interactivity, especially under conditions of heightened time pressure. A further, unanticipated addition to the field research effort was participation in the Rim of the Pacific Strong Angel 2000 humanitarian assistance/disaster relief (HADR) exercise that was conducted jointly by the United Nations, the Third Fleet, representatives of all branches of the U.S. Armed Forces, and six other cooperating nations. This massive simulation of hostilities between neighboring countries and creation of a camp for fleeing refugees provided an ideal "field laboratory" for examining ways in which collaborative communication and coordination could be established among leaders with diverse backgrounds and goals, under highly adverse conditions.

Effects of Participation on Interactivity, Trust and Performance

As described previously, participation refers to the orientation of one participant toward another regarding their ability and rights to contribute to and experience discussion. In many cases, people are not full participants of interaction but rather observers of it. As other research has demonstrated (Burgoon, Buller & Floyd, 2001; Burgoon & Newton, 1991; Dunbar, Ramirez & Burgoon, 2003; Fleming, Darley, Hilton & Kojetin, 1990; Schober & Clark, 1989), one's role affects interaction outcomes such as credibility judgments and processing of information.

The first study, reported in Bonito et al. (2000b), examined the structural property of participation. As noted in our definition of interactivity, the degree to which interactants participate in the communication process is a fundamental part of human communication. Based on the model of interactivity, we predicted that *those who hold the role of participant in an interaction will differ not only in their perceptions from those observing the interaction, but will also be more influenced than passive observers*. The present experiment tested the extent to which participation influenced communicator assessments, interaction assessments, and task outcomes.

The decision-making task employed was the Desert Survival Problem (DSP). The narrative simulates an emergency in which survivors of a jeep crash in the Kuwaiti Desert are to sort through a list of salvaged items and rank them in order of importance. They are required to first complete independent rankings then discuss the problem with a task partner and arrive at a consensual set of rankings. Because experts have supplied their recommended rankings for this problem, an objective assessment of decision quality is available, namely, the extent to which the pair's decisions match or deviate from the ideal rankings.

Changes in an individual's rankings from pre-discussion to post-discussion toward those advocated by the partner or target communicator also index the amount of influence that person exerted. Participants worked on the DSP in one of two interaction conditions: (1) two naïve participants interacted with each other or (2) one naïve participant interacted with an experimental confederate. Observers watched the videotaped interaction from one of the two conditions, rated the observed communication patterns, rated one individual on trust, and also completed the DSP rankings.

Results indicated that participants perceived more receptivity and involvement by the target team member than did observers. Participants also reported the interaction was more expected and more positive than observers' reports. However, contrary to expectations, participants did not report increased similarity or mutuality with the target person and were not influenced by them more, even though they judged them as more credible than observers did. Assuming the nonsignificant differences were not attributable to having a statistically underpowered test, one important implication is that participation is not a necessary prerequisite to achieving influence. Persuasion does not decrease if one merely observes an interaction. Put differently, one needn't introduce an active or dynamic medium into a project if the goal is to persuade passive recipients, at least for tasks that have identifiably correct answers, as was the case here. We should note that we did not test the indirect influence of participation on influence. Our statistical models across previous studies have been relatively consistent in specifying that interaction processes are affected by features of CISs (participation, in this case), and that interaction processes in turn affect outcomes. Correlations from previous studies have served as evidence for this claim. The best test of this theoretical model, a path analysis, requires far more subjects than was possible here. On the other hand, participants did rate their partners as more involved and receptive than did observers. Thus, participation is beneficial to promote task engagement and greater perceived or actual openness by team members.

Two other related studies of participation reveal that participation is not always warranted and can be a double-edged sword. An experiment reported in Dunbar, Ramirez, and Burgoon (2003) investigated the effects of participation (i.e., participant-receiver versus observer) from the perspective of the receiver of deceptive communication. Several hypotheses were advanced in this study. First, because greater participation affords increased involvement and mutuality between participants, and should thereby intensify positivity biases and halo effects, it was hypothesized that *compared to observers, participant-receivers would judge participant-senders' communication more favorably on involvement, dominance, pleasantness, and rapport/similarity/trust* and *would judge participant-senders' communication as more credible.* Next, it was reasoned that since observers are less involved in the conversation, and hence, do not have as great a positivity bias toward the sender as do participant-receivers, *observers would be less likely to pick up on unexpected behavior.* Finally, *participant-receivers should be less accurate at detecting deception than observers, especially when participating in dialogue rather than monologue.* Additionally, a research question was included which inquired as to what specific cues are used by participant-receivers versus observers which influence their judgments of deception and truth.

Upon reporting to the laboratory, participants were randomly assigned to participant-sender (Person A), participant-receiver (Person B), and observer roles. Half of those in the participant-sender role conducted a dialogue and the other half conducted a monologue with the receiver. Under dialogue, each topic was read and both participants discussed their responses to it before moving on to the next topic. Participants in this condition were encouraged to have a normal conversation in which they could ask questions of each other, interject their own opinions, and extend upon what each other was saying. Under monologue, participants were told that first Person A would read and respond to all topics without allowing for questions or verbal input from Person B, and then Person B would do the same. Following the interaction, participant-receivers and observers reported to separate rooms to watch the videotape of two of the topics they discussed, one in which Person A gave a truthful response and one in which Person A gave a deceptive response. After watching each topic, participant-receivers and observers completed written post-measures.

Results supported the hypotheses. Participant-receivers judged senders as more involved and pleasant than did observers and judged senders as more competent, more dominant, and of higher character. Participant-receivers also assessed the communication style of participant-senders as more expected than did observers. Finally, participant-receivers were found to be significantly less accurate at detecting deception than observers. Of the cues responsible for judgments of truthfulness, involvement was the most salient. The

more involved senders were perceived, the more accurate observers were in judging truthful messages, but the worse participant-receivers were in detecting deception.

These findings strongly point to the value of nonparticipation if one wishes to avoid becoming the victim of a sender's attempt to deceive. Consistent with the principle of interactivity, being an active participant in a communicative event confers a net advantage on senders to the extent that increased involvement in a communicative exchange engenders feelings of mutuality and trust. The greater the sense of mutuality, the more likely recipients of deceptive messages are likely to judge the sender as veracious. Hence, from the perspective of the receiver, the detachment of the observer perspective is desirable if successful detection of deception is to occur. By contrast, from a sender vantage point, engaging the receiver in a direct communicative exchange carries the best prospect of being believed.

A companion to the above study, reported in Burgoon, Buller, and Floyd (2001), investigated the effects of sender participation on perceptions and performance by having one of the participants discuss topics under dialogue, in which they had a normal conversation with the other participant, or under monologue, in which they gave all their responses to the topics before the other person spoke. Based on the prior reasoning, it was predicted that *mutuality, coordination, and trust should be greater under dialogue than monologue.* Another hypothesis predicted that performance would be affected: *deception detection accuracy is lower (a) under dialogue than monologue, and (b) worsens over time under deceptive dialogue.* Two other hypotheses predicted that communication patterns would also differ. An experiment was conducted in which friends and strangers alternated between deceiving and telling the truth to a partner under dialogue (high participation) or monologue (low participation) conditions. Following the interaction, participants reported to separate rooms to watch and rate the videotape of Person A giving a truthful response and a deceptive response.
Results confirmed that participation did indeed affect mutuality (receiver perceptions of rapport and similarity), behavioral coordination, and trust but in different ways depending on the relationship. If senders interacted with friends, mutuality was higher under dialogue than monologue, but coordination did not vary, perhaps because friends' interaction patterns were too stable and ingrained to be responsive to a relatively brief experimental manipulation. If senders interacted with strangers, mutuality, coordination, and trust all were higher initially under dialogue than monologue, and the coordination advantage held up over time. Participation also enabled senders to manage their communication better and to successfully deceive the interaction partner. However, over time, both deceptive dialogue and deceptive monologue yielded less accuracy than truthful responses. As such, results remain equivocal as to whether dialogue achieved a marked benefit over time.

These findings, like the preceding ones, argue in favor of leaders opting for a CIS that minimizes participation between team members and any suspicious information source if they wish to succeed in detecting invalid and untrustworthy information or ulterior motives. Because participation may create greater rapport, perceived similarity, and trust, dialoguing may develop a sense of common ground and relational oneness that leads to communicators being given the benefit of the doubt. A greater sense of mutuality and the dynamics of a participative interaction format also may facilitate senders' adaptation of their demeanor to approximate seemingly truthful behavior and win others' trust. This mutuality and interaction adaptation becomes attenuated or severed once interaction shifts into a unidirectional or monologic form, something that is inevitable once individuals shift to an observer role or interaction becomes asynchronous. Thus, if successful detection is the aim, nonparticipative communication formats which inhibit feelings of connection and similarity and which preclude coordinated two-way conversation should be employed.

Effects of Mediation and Propinquity on Interactivity, Trust and Performance

This experiment, reported in Burgoon, Bonito, Ramirez, Dunbar, Kam and Fischer (2002), tested the effects of two structural properties, mediation and propinquity. Mediation refers to the interposition of an

electronic or mechanical medium by which messages are transmitted between actors. Usually "mediated interaction" refers to transmission via computers (although technically, telephones, telegraphs, or even pencil and paper would qualify). Relative to FtF interaction, mediated interaction typically entails shifting from an oral mode, in which the full range of nonverbal visual, auditory, haptic, proxemic, and environmental cues is available, to a written, text-only one (although the emergence of voice mail and computer telephony may eventually supplant text-based forms).

Propinquty (also referred to as proximity) refers to geographic closeness or distance. With the exception of group decision-making support systems (GSS), in which team members are located in the same place but use computers to conduct much of their interaction in text mode, the structural affordances of mediation and proximity are interrelated because mediated communication is usually also at a distance, i.e., it is geographically distal. Thus, comparisons between FtF and CMC may conflate mediation with proximity as well as other aspects of modalities such as the amount of information they afford (discussed next). Differences between FtF and CMC, then, do not necessarily reflect mediation differences alone; they may actually represent differences due to a combination of factors.

From the standpoint of the principle of interactivity, the issue is whether mediation and/or reduced proximity, both of which may constitute structural reductions in the capacity for interactivity, have adverse effects on interaction processes themselves and on interaction outcomes. One highly relevant consideration is that both mediation and proximity affect nonverbal immediacy, which refers to a constellation of nonverbal behaviors (e.g., physical proximity, eye contact, touch, body orientation, body lean) that enable sensory immersion and create psychological closeness as well as physical and social presence (Coker & Burgoon, 1987; Mehrabian,1981; Short et al., 1976). According to Mehrabian (1981), these behaviors communicate interest and warmth between communicators. Presumably, nonverbal immediacy is more readily achieved through FtF interaction than via CMC (the exception being GSS). When communicators are in close proximity, they have access to both intended and unintended behaviors that may not be available to them when they are distributed. Even in GSS environments, where written messages replace oral discourse, communicators still have access to numerous nonverbal cues.

Furthermore, physically co-present interactants may entrain to each other's speech rhythms and nonverbal behavior, coordinating and synchronizing their communication into a unified, smooth-flowing pattern, all seemingly without conscious awareness (see, e.g., Burgoon, Stern, & Dillman, 1995, for a review). These are the kinds of interactional qualities that mediation may dampen or eliminate. If this is the case, then an argument can be made that FtF interaction should foster higher levels of involvement, interaction coordination, and mutuality among collaborators than should CMC. On the other hand, for straightforward tasks, provision of social information via nonverbal cues or a novel technology may elevate users' cognitive load and redirect their attention to social considerations, making it more difficult to complete their task efficiently. If this is the case, task-related credibility judgments and performance might actually be higher under CMC. In light of the competing possibilities regarding the influence of mediation, we tested a non-directional hypothesis: *Mediated interaction differs from nonmediated interaction in communication process qualities and outcomes.*

The case for proximity should be less equivocal. Extensive nonverbal literature has demonstrated that the correspondence between physical and psychological closeness is direct and potent: Physical proximity promotes psychological closeness, and physical distance conveys psychological distance. Moreover, sheer proximity between two people activates perceptions of a unit relationship between them. It creates a sense of mutuality, of connection, common ground, and shared understandings (Burgoon, Stern, et al., 1995; Foppa, 1995; Krauss, Fussell, & Chen, 1995) that should heighten already existing positivity and truth biases (e.g., Burgoon & Newton, 1991; Stiff, Kim, & Ramesh, 1989; Storms, 1973; Street, Mulac, & Wiemann, 1988; Weisband, Schneider, & Connolly, 1993) and promote higher levels of credibility, trust, and influence. This assumes that credibility is central to influence processes (McGuire, 1985) and that

sources or messages deemed more believable are also more influential (Burgoon, Birk & Pfau,1990; O'Keefe, 1990). Conversely, concerns about self-presentation, protecting another's face, maintaining an amicable and trusting relationship, or assuring a comfortable interaction should pale as interactants become physically and psychologically removed from another. Participants, therefore, should have more difficulty establishing credibility and influencing partners to adopt "best" decisions when not physically co-present. Therefore, we tested as a second hypothesis that *proximal interactions result in more favorable interaction processes and outcomes than distal interactions.*

To test the two hypotheses, participants conducted a decision-making task under one of three conditions: FtF (which is unmediated and proximal), proximal text (which is proximal but mediated), and distributed text (which is both mediated and distal). The FtF condition was identical to that for participants interacting with a confederate in Experiment 1. In the proximal text condition, the participant and confederate were located at side-by-side computers. They conducted their task discussion via text using a synchronous online chat program and had access to each other's nonverbal cues. In the distributed condition, participant and confederate were located in separate rooms and interacted with a synchronous online chat program (Microsoft's NetMeeting). The experimental task was again the Desert Survival Problem. After discussion of rankings for the desert survival items, subjects completed a set of post-interaction questionnaires, which included interactivity measures (perceived involvement, mutuality, receptivity, similarity, perceived connectedness and perceived understanding), social judgment measures (credibility, dominance, utility, and task partner attraction), and task outcome measures (decision quality and influence).

The first hypothesis failed to receive support except on interaction coordination, although the means for several other measures would have been significant with one-tailed tests. The patterns suggest that, while the more familiar FtF format is positively regarded, the introduction of mediation per se does not inevitably degrade interaction processes and may even confer an advantage by supplementing FtF interaction with a more permanent, recoverable verbal record. Thus, any dampening or elimination of nonverbal cues may actually heighten attention to the verbally transmitted information. For task-oriented contexts, as was the case in this experiment, this can be beneficial. These patterns would, however, need replication before any firm conclusions could be drawn.

The general examination of proximity showed that it is a far more salient consideration in selecting and evaluating interfaces. Hypothesis 2 was supported: Interactivity in the form of connectedness and involvement was higher in the proximal than the distal conditions, as were social judgments of sociability, utility, and task attractiveness. These findings imply that proximity is an important factor in evoking involved, mutual interaction and positive evaluations of team members, a conclusion bolstered by extensive nonverbal research literature. Actual or perceived distance can indeed weaken people's task engagement, their sense of connection with one another, and the credibility they ascribe to task mates.
Two studies that served as pilot projects for this research also merit mention here. The first, a human-computer interaction (HCI) study reported in Bengtsson, Burgoon, Cederberg, Bonito, and Lundeberg (1999) and Burgoon, Bonito, Bengtsson, Ramirez, Dunbar, and Miczo (1999) was conducted with 70 students in Sweden who interacted either face-to-face, in a contingent or noncontingent fashion, or with a computer agent with varying degrees of modality richness and anthropomorphism. This study produced not only the first test of mediation but also tests of the affordances of contingency, modality richness (relevant to Experiment 3) and anthropomorphism. It consisted of five HCI conditions, ranging from text-only to a human-like image with synthesized speech and matching lip synchronization, and two FtF conditions where human partners presented the same scripted responses as in the HCI condition but under two variations. They either adhered to the script, producing a largely noncontingent form of interaction, or they interacted "freely" while using the same script. The task was the DSP.

The second study, reported in Burgoon, Bengtsson, Bonito, Ramirez, and Dunbar (1999), used the same methodology but compared humans interacting under unmediated or mediated conditions. A control group

was created in which two naïve participants conducted the same task face-to-face. This condition was intended to serve as a benchmark for how users would conduct and experience this task when permitted to interact freely in the absence of experimental controls over the communication process itself. The other two conditions represented contingent, unmediated FtF interaction and contingent CMC among co-located participants, respectively. Like electronic group support systems, the latter condition retained the proximity of FtF interaction but introduced mediation in the form of text-based interaction. Participants sat beside one another but could not talk during completion of the task.

Results from the HCI study failed to support the prediction that adding humanlike features to interfaces would produce monotonic increases in influence, credibility, or understanding. Instead, the results revealed that increased anthropomorphism in the interface created greater perceptions of receptivity, being understood, and utility of the interface. In addition, the combined features of the animated computer agent (text + voice + animation) made the agent seem dominant, competent, and confident. Other interesting results had relevance for interface design. For example, computer agents were seen as more dominant in the text-only interface than the text-voice combination. Moreover, findings indicated that the addition of a still image reduced credibility to the average of text-only and text + voice conditions. Comparisons of human and computer partners on user assessments revealed that FtF interaction created more sense of receptivity and being understood compared to HCI conditions. In addition, partner behavior was seen as more expected and desirable under the FtF conditions. Contingent FtF could therefore be characterized as a positive confirmation of expectations and as the condition most likely to create mutuality as well as credibility. Interestingly, the noncontingent FtF condition received among the lowest ratings on both expectedness and evaluation, making it a case of a negative violation of expectations.
Overall, face-to-face interaction emerged as best for generating positive social judgments and interpersonal relationships, but mediated communication and computer agents were better for task performance and exerting influence. These results indicated, first, that mediation per se is not problematic for task performance, only for social goals, and second, that richer or more anthropomorphic interfaces may be unnecessary to achieve influence. Paradoxically, those qualities may need to be included when the desire is to mitigate what might otherwise be undue influence by a computer agent.

In the computer-mediated communication (CMC) study, partners in the experimental conditions were more influential that those in the control group on average. They were also perceived as more dominant. Conversely, partners in the control group were perceived as more receptive than those in the two experimental conditions. Comparisons of CMC to the two FtF conditions revealed that team members in the mediated conditions were seen as more competent, involved, and attractive as task partners, and tended to be more influential, than those in the FtF conditions. When the CMC condition was compared just to the experimental FtF conditions, however, only perceived involvement and task attraction were significantly different. In both cases, CMC earned higher ratings. In sum, the CMC condition did not suffer on involvement, mutuality, or credibility and in fact gained on task-related perceptions and actual performance relative both to the control group and, in some cases, the unmediated FtF condition.

Analyzing the efficacy of different types of computer-based communication, these findings imply that different interfaces prove more effective than others in achieving certain communicative goals. These considerations should guide leaders' selection of interfaces, where the option exists to select among different alternatives, and should alert leaders to potential problems to forestall when a given interface is required. Selecting an interface requires a thorough understanding of the communicative goal and matching the interface to the outcome objective. In analyzing goals, three global outcomes stand out as relevant: (1) passive involvement, (2) collaboration, and (3) relationship building. Within each of these categories, results revealed that certain interfaces are more effective in achieving predefined outcomes than others. For passive involvement, in which the participant is cast as a receiver of information but takes little or no role in creating it (e.g., results from a web search engine), interface requirements need only to consist of text-based communication or text plus audio features. This statement applies only to HCI, since text-based CMC

doesn't produce the same effects. In selecting an interface for collaborators, the focus must be on fostering an increased sense of involvement, mutuality, coordination, and identification. Users in this type of situation are essentially equal partners who are expected to participate actively in generating information and knowledge. Anthropomorphic interfaces incorporating animated characters, speech synthesis or artificial intelligence are more appropriate when collaborative encounters are desired, inasmuch as participants take a more active role in the interaction when these features are present. Finally, relationship building concerns creating and maintaining useful and positive assessments of interactional partners. Anthropomorphic interfaces would seem appropriate for relational building because respondents tend to rate their partners and interactions higher when more human features are provided.

Effects of Modality Richness on Interactivity, Trust and Task Performance

This investigation, also reported in Burgoon, Bonito, Ramirez, Dunbar, Kam and Fischer (2002), examined the affordance of modality richness. The concept of richness has particular relevance to the examination of interaction processes because it directly reflects the relative importance of verbal and nonverbal channels to interaction outcomes such as credibility and team performance. Daft and Lengel (1984) define richness as the degree to which the information carried by a given medium creates a sense of mutual understanding between participants. Among the factors contributing to this capacity are the number of communication channels through which participants can glean social and contextual information and the feedback capability of the given medium. Within this framework, leaner modalities can affect interaction by reducing the total information available to participants for the formation of social judgments, as well as by reducing the amount of redundant and complementary information that may contribute to mutual understanding.

These reductions are thought to alter the communication quality and interpersonal character of interactions. According to Rutter (1984), a reduction in cues leads to greater psychological distance and depersonalized communication. In addition, relative to multichannel modalities, leaner modalities restrict feedback processes (Barefoot & Strickland, 1981; Fowler & Wackerbarth, 1988; Weick, 1995). Daft and Lengel (1984) state that this restriction can lead to the oversimplification of complex topics in leaner media as a result of the medium not allowing for information exchange sufficient to alter a participant's understanding.

Despite these findings, however, a reduction in cues does not necessarily produce a linear decline in communication quality, social judgments, or task performance. Instead, modality choice appears to be mediated by the purpose it is intended to serve. In particular, researchers have found that the presence of audio cues and the absence of visual cues enhanced communicative processes, social judgments, and the quality of collaborative interactions (Chilcoat & Dewine, 1985; Jensen, Farnham, Drucker, & Kellock, 2000; Stoner, 2001). The presence of audio cues in the absence of visual ones provides immediate feedback and allows rapid information exchange in the absence of visual cues that could divide participant attention and create additional cognitive demands that could detract from task attention. In addition to the potential for task distraction, feedback immediacy is hindered by typing speed in text modalities and can be hindered by deficiencies in current videoconferencing interfaces. These deficiencies further appear to privilege audio conditions for task-oriented, decision-making activities. Consequently, we predicted greater mutuality, involvement, coordination, and favorable social judgments in FtF interaction than CMC, and among CMC formats, a rank-ordering from vocal to audiovisual to text-only in terms of favorable results. Task performance should also follow this pattern. Stated formally, *interactivity and performance decline as one moves from FtF to audio to audiovisual to text-based CISs.*

Participants were 80 male and female students who were paired with a trained confederate working from an interaction script. Teams were randomly assigned to one of five CIS conditions--FtF, proximal text, distributed text, distributed audio-conferencing, or distributed video-conferencing–to conduct the Desert Survival Problem. Afterward, team members rated the communication and the confederate.

Results showed that the audio and proximal text conditions were the best for trust and other credibility judgments. Contrary to expectations, performance was higher in the mediated conditions than in FtF

discussion. These results reveal that the desirability of a given interface depends on what one hopes to achieve--higher involvement, greater mutuality, favorable social judgments, or task performance. The benefits of the audio condition may derive from the aforementioned rhythmicity of speech–a key ingredient in establishing interactional coordination and rapport, from the gains in comprehension that come from the vocalic (paralinguistic and prosodic) features of spoken language, and/or from the diagnostic value of vocal cues, which, woven together with verbal content and linguistic style, reveal richly detailed, often unmonitored social information (Burgoon & Hoobler, 2004). The proximal text results suggest that physical proximity and availability of other visible nonverbal cues may be sufficient to offset the loss of the audio channel. This particular format also capitalizes on a division of labor, with the verbal channel devoted exclusively to the task at hand while nonverbal channels do the social work, so that tasks can be accomplished efficiently without concomitant losses on the social dimension, thus accruing both task and social pay-offs. Video-conferencing was least desirable on most fronts but did exceed FtF interaction in terms of performance, doubtless because all the mediated conditions created more task focus than was present in the unmediated FtF condition.

Two related studies support the foregoing conclusions. A dissertation by Ramirez (see Ramirez & Burgoon, 2001) tested the four modalities of FtF, text, audio-conferencing, and video-conferencing in the context of uncertainty reduction and relationship development. Ramirez found not only that mediation per se had no impact but that modalities by which participants interacted had limited effects on communication qualities and relationship development. One exception was that the audio condition created more feelings of connectedness than did the text condition, a finding that reinforces the special properties of the audio channel. Far more important in predicting relational outcomes were the intervening communication processes.

Similar results obtained in a thesis by Stoner (2001), which examined the influence of richness, mediation and time pressure on communication quality, social judgments, and decision quality. Participants interacted in one of three communication modes (FtF, audio-conferencing, and video-conferencing) and under one of three levels of time pressure (high, medium, and low). Each dyad completed a social task followed by three Moberg and Caldwell (1989) decision-making tasks. Participants completed measures of task load after each decision-making task, then completed measures of thirteen dimensions of communication quality at the conclusion of the third decision-making task. The three communication formats did not differ significantly in ratings of relational quality. However, communication quality and decision quality differed between the two mediated conditions, with the audiovisual modality routinely producing less quality communication and performance than the audio modality.

The overall trend of greater communication quality in the audio-only condition further challenges the assumption that richer is better. Indeed, the presence of the visual channel introduces more social information into an interaction, which can hamper the processing of task-relevant information. Humans, as cognitive misers, seek efficiency and selectively filter information. When this information is key to decision-making this could result in negative outcomes. If a technology, such as a video conferencing system, is not essential to the interaction, it can influence perceptual processes by distracting attention away from the central task.

Effects of Modality Richness, Longitudinal Replication

The fourth experiment, reported in Burgoon, Bonito and Kam (in press), was a companion to the prior cross-sectional study (discussed above) which examined the effects of mediation, propinquity, and communication modalities on interactivity, trust, and influence. This follow-up study tested the temporal changes related to increased familiarity with team members and technologies, and employed multiple tasks. Hence, this longitudinal study was designed to test that, with sufficient time, participants would be able to adapt to lean and distal mediated formats, and might even realize performance benefits because of their freedom to limit attentional resources to fewer channels of information.

Contrary to prior theorizing, the principle of interactivity maintains that structural properties of interfaces do not have sole and deterministic responsibility for outcomes. Rather, the interaction processes mediate structural impacts. As such, either structural or processual features, singly or in combination, may be responsible for the positive or negative consequences that a CIS yields. Given these circumstances, we speculated that the *structural features of CISs indirectly affect trust and task performance via their effect on interactivity* add that *differences across modalities (FtF, text, audio, audio-visual) would attenuate over time.*

To test this basic premise, students were recruited to conduct multiple tasks across two weeks under one of four CISs: (1) *FtF*, which is unmediated, proximal, and afforded participants full access to each others' verbal and nonverbal behavior; (2) *distributed text*, in which the pair, located in separate rooms, conducted their discussions via synchronous online chat (Microsoft NetMeeting); (3) *distributed audioconferencing*, in which the separated pair interacted via NetMeeting with only the audio channel enabled; or (4) *distributed videoconferencing*, in which the separated pair interacted via NetMeeting with both the audio and video channel enabled. At time 1, participants completed the Ungame, get-acquainted task and one of the Moberg and Caldwell case studies (a problem-solving effort in which participants must reach consensus at a series of decision-points in order to arrive at a solution to the given problem).

At time 2, participants participated in a modified and updated version of the Desert Survival Problem (DSP), a decision-making task in which participants were asked to imagine that their jeep had crashed in the Kuwaiti desert, and that, for survival, it was their task to rank-order and discuss together the twelve items that were salvageable from the crash. After each task, team members rated the communication and teammate credibility.

Results revealed several time effects such that team members reported more involvement, mutuality, coordination, task focus, ane trust across time, regardless of what CIS they used. These findings suggest that the richness of the communication modality does not necessarily advantage relationship-building. Interactants are capable of establishing congenial and trusted working relationships under even the leanest of modalities, and some of the leaner modalities may be preferable for certain goals such as mutuality and similarity. It also appears that the structural features of CISs assume a less pivotal role than interaction processes themselves in their influence on credibility and task performance. Team members manage to attain their relational and interactional goals regardless of the communication medium adopted. Further, the results bolster earlier findings that communication modalities are not deterministic in nature, and visual information is not essential for achieving effective communication or performance. A further implication of this study is that the task of getting acquainted with an unfamiliar other does not require face-to-face interaction. The upward trend in social judgment ratings across each of the communication modalities suggests that people are fully capable of developing quality relationships with unfamiliar others despite the constraints of certain technologies in transmitting nonverbal information. Team members were able to establish a sense of involvement, similarity, understanding, and connectedness over time with communication formats other than just face-to-face interaction.

Effects of Propinquity and Synchronicity

The next investigation explored the impact of the two related affordances of proximity and synchronicity on communication quality and decision-making effectiveness over the course of two multi-phased decision-making tasks. It also examined whether any impacts persisted over the two-week time course of the experiment or evidenced some degree of adaptation to the tools. This investigation is reported in more detail here because it has not been reported elsewhere yet.

Among the collaborative technologies that have been embraced for teamwork are computerized group support systems. An exemplar is GroupSystems®, a commercially available suite of software tools that

enables electronic brainstorming, idea prioritization and categorization, topic commenting, voting and statistical analysis of results. Such electronic meeting systems, beyond permitting large and unwieldy groups to collaborate efficiently and encouraging wider participation among group members, can greatly accelerate group deliberations and productivity. These systems initially were developed for use by co-located groups, i.e., those assembling in the same place. But the Internet has paved the way for their use with distributed teams, i.e., those whose members are in different places. As collaboration at a distance becomes more commonplace and a frequently selected alternative to costly travel, the natural question to be addressed is how well such systems enable leaders to achieve their goals and how well they facilitate team work. Can such tools effectively bridge distance and time? What is the quality of communication that results? The current investigation sought answers to these questions.

In the shift from co-located groups to distributed ones, two structural features of group support CISs are particularly relevant: *proximity* and *synchronicity*. Co-located groups are by definition proximal; group members share the same geographic locale, share the same environmental context, and have full access to all the nonverbal cues--physical appearance, kinesic demeanor, vocalics, proxemic and haptic behavior–that are available in face-to-face (FtF) encounters, although more of the task may be conducted via written than oral mode. Distributed groups are, by definition, distal; individual members or subgroups are located in different locales. Any differences between proximal and distal groups may therefore be a function of geographic separation and the concomitant loss of available nonverbal cues that such a shift entails. Distributed groups in turn may communicate either asynchronously–where messages are sent at different times, with varying delays between transmissions–or synchronously–occurring at the same time (as is the case with FtF interaction). Email is an asynchronous mode of interaction; instant messaging and Internet chat are synchronous. Differences in the effectiveness of electronic meeting systems and other computer-based tools may be a function of whether the tools are used for same-time or different-time work.

To conduct this experiment, we obtained access to groups of employees of a health organization, who, in the course of a multi-year project studying smoking prevention and cessation, were brought together to conduct two different decision-making tasks under synchronous or asynchronous conditions. For this kind of straightforward, noncontentious task, the optimal, expected, and appropriate communication pattern should be a congenial one in which group members feel connected, similar, and understood (i.e., high mutuality), the communications are positively toned, members are able to effectively synchronize conversational turns and pace the discussion, members are fully engaged in the task, information-sharing is detailed and unrestrained, and members engage in thorough analysis and evaluation of proffered ideas and strategies. The first hypothesis tested whether these communication qualities are more present under proximal than distributed communication: *proximal communication elicits more involvement, mutuality, pleasantness, coordination, and task-oriented communication, and such communication is judged as more appropriate and expected, than distributed communication.* Although we anticipated that proximity would foster more of the desired communication qualities, it was possible that proximity would instead divert some of the interactional focus away from the task and toward social dimensions, thus making the distal format preferable for task focus. It was also possible that the second property– synchronicity–might be sufficient to overcome the psychological disengagement associated with distance.

Although research has begun to address the effectiveness of various synchronous CMC modes, research comparing synchronous to asynchronous modes is sparse. A study by Siegel, Dubrovsky, Kiesler, and McGuire (1986), for example, compared synchronous and asynchronous text-based interaction to FtF interaction for the impact on communication efficiency, participation, interpersonal behavior, and group decision choices but was only able to draw conclusions about the two CMC conditions relative to FtF. Both CMC groups showed less participation, but more equal participation, and more uninhibited, hostile messages, than the FtF group. However, this does not speak to the impact of synchronicity. Still, synchronous communication intuitively has a number of advantages (see, e.g., Dennis & Valacich, 1999), such as providing users with the capacity to receive immediate feedback and to adjust their messages

accordingly. It should enable better coordination among interactants not only by virtue of the linguistic coherence mechanisms immediately available to assist participants in threading their contributions into the total discourse but also by affording interactional synchrony–the rhythmic qualities of the vocal-verbal stream that are fundamental to participants synchronizing and entraining their communication with one another. Too, by capitalizing on temporal immediacy, synchronous communication should promote involvement, personalization, and mutuality. When team members simultaneously accomplish a host of communication tasks (e.g., "reading" what the situation is, producing messages that are understandable to others, comprehending others' messages, structuring and managing the conversation, managing impressions, exerting influence), they may come to view one another more sympathetically and as "partners" in creating the ongoing discussion. From this joint co-construction of the ongoing interaction should come more mutual concern for establishing positive relationships, efforts to exchange pleasant communication, and judgments of each other's communication in a favorable light, e.g., as expected and appropriate. By comparison, asynchronous communication may create a sense of distance, nonurgency, disassociation, and depersonalization. Thus, the second hypothesis tested that *synchronous communication elicits more mutuality, pleasantness, involvement, and task-oriented communication, and such communication is judged as more appropriate and expected, than asynchronous communication.*
The tasks in this investigation were conducted over a two-week time frame so as to assess whether effects persist over time or are transitory. Given our view that relationships between structural properties and interaction processes are by no means intractable and that humans are quite capable of making adaptations to new media, we speculated that the effects of proximity and synchronicity might diminish over time. Employees from the university-affiliated hospital were recruited via flyers to participate in a study to assess computer-based decision-making among health workers. Participants were randomly assigned to groups in one of three conditions: (1) asynchronous distributed, (2) synchronous distributed, or (3) synchronous proximal (face-to-face). All completed two major decision making tasks using GroupSystems® software. All groups had a facilitator, who led the meetings and was responsible for moving them through the various tasks and use of system tools to accomplish them; a technographer, whose role was strictly to manage the computer system and load tools; and other technical assistants, who were available to answer any questions regarding use of the system but not to interact with participants. Synchronous groups met together twice over a two-week period for up to two hours and engaged in a different task during each meeting. In the synchronous/face-to-face condition, all team members were in the same room and could see and interact with one another. In the synchronous/distributed condition, half of the participants were in the same room as the facilitator and technographer while the other half were simultaneously located in a different classroom with a technology assistant and teams communicated via speakerphone. Asynchronous groups participated in the same tasks as the synchronous groups but were asked to come in a total of nine times throughout a one-week period to complete the two tasks and communicated via email. Task 1 consisted of selecting a medium found in their hospital (e.g., closed circuit television, poster sessions, flyers) and designing a tobacco cessation program using that medium. Task 2 consisted of creating new benefits as well as enhancing/changing current benefits they received as employees of the organization. After each task, they completed a web-based questionnaire rating the interaction and team members.

Results supported the benefit of synchronous over asynchronous interaction in terms of involvement, mutuality, coordination, pleasantness, expectedness, and appropriateness at Time 1 but not Time 2. The predicted benefits of proximal interaction failed to received support. Instead, the distributed condition achieved more favorable ratings on coordination, appropriateness, and expectedness. Because these results are opposite predictions, they must be regarded as merely suggestive but they at least indicate that communication qualities in the synchronous distributed condition were at least on par with those in the proximal (co-located) condition. Examination of changes over time showed that the asynchronous condition remained the same and lowest in positive qualities. The distributed synchronous condition actually showed a decline over time, whereas the proximal (face-to-face) condition showed improvements. These data indicate that participants in the distributed conditions did not show favorable adaptations over time; only those in the co-located condition did. The absence of temporal effects on other measures and

aforementioned lack of differences at Time 2 imply that any shortcomings of asynchronous interaction, or any unique advantages of synchronous interaction, dissipated over time. Put differently, the null findings on these latter measures, though clearly not interpretable as positive support for a claim, leave open the possibility that actors adapted to the different communication formats to achieve effective task-oriented communication and language use, irrespective of distance or temporal delay. But this is obviously a tentative and tenuous conclusion.

Multiple regression analyses on individual members' ratings were undertaken to identify which communication factors were most associated with decision-making satisfaction. At Time 1, participants reported more effective decision-making communication when there was higher positivity, more dominance and influence by group members, and better interaction coordination. Positive and unexpected behavior, i.e., a positive expectancy violation, produced the most favorable outcome. At Time 2, the best predictors of more satisfying decision-making communication were the richness of information exchanged and amount of interaction coordination. These latter findings speak to the relationship of process variables to outcomes. Several qualities were strongly associated with more satisfying and seemingly effective group deliberations. Groups that had higher coordination of the conversations, adopted more pleasant demeanors, gave richly detailed contributions to the group discussion, and yet were willing to be assertive and persuasive, had members that were more satisfied with their deliberations. The groups' communication could also be atypical, as long as it was positive. In fact, positive violations of expectations created the most favorable assessments of decision-making effectiveness, a result consistent with numerous tests of expectancy violations theory that have demonstrated that positive expectancy violations yield better outcomes than expectancy confirmations (Burgoon & Burgoon, 2001).

Of the two communication affordances examined here, synchronicity had more impact than did proximity. Relative to its comparable asynchronous version, the synchronous distributed arrangement enabled more mutuality, interaction coordination, positivity, and composure, and such communication was generally perceived as more appropriate and expected. Additionally, synchronous interaction was more involving. In the language of the principle of interactivity, synchronicity enabled and promoted higher interactivity. These results offer clear guidance for selecting between the two alternatives:

Synchronous interaction is clearly superior for attaining the kind of positively valenced interaction so essential to establishing strong social relationships as well as creating a climate that promotes greater long-term solidarity and commitment to the group and its products. Conversely, use of the asynchronous option risks losses on the social dimension. Moreover, the asynchronous format required significant investment in facilitation and technical support in the form of "angels" at each site who were available to insure that group members knew how to use the GroupSystems tools properly and to troubleshoot and problems. Although the asynchronous option may be less costly in some tangible respects, these results point to it being more costly in some intangible respects. For leaders contemplating between synchronous or asynchronous formats for collaborative work and distance learning, the current findings stand as an endorsement for the former. The results also warrant active strategies to deter reductions in mutuality and involvement.

As for proximity, the current results were contrary to the hypothesis. The distributed synchronous condition actually exceeded the co-located (face-to-face) condition on some measures and did not suffer any losses of mutuality, involvement, or task-related communication as a function of groups working at a distance. These results stand in sharp contrast to those of Burgoon et al. (2002), who found that proximity conferred significant advantages in terms of high-quality communication and social judgments. However, in retrospect, it is perhaps unsurprising that the distributed group did as well or better than the FtF group because, unlike the Burgoon et al. investigation, where pairs interacted from separate locales, half of each the current groups shared the same locale, so that subgroups, rather than all members, were geographically separated. This meant that the distributed synchronous condition actually combined some of the properties

of face-to-face interaction–among those who were in the same room together–with possibly greater task focus and expenditure of effort to coordinate with the "distant" half of the group. These results are encouraging that as long as all individuals are not isolated from each other, effective communication can still be accomplished. As a caveat, social judgments were not collected in the current project, leaving unanswered whether members judged those in their same locale differently than those at the remote site. Future research might profitably compare groups with each individual at a separate site to those with subgroups at each site and assess not only the quality of the communication process but also resultant judgments and group productivity.

A final issue addressed was whether effects of structural affordances of CISs are transitory, due to participants adapting to any constraints imposed by the communication format. Previous research has shown that users of electronic meeting systems and other forms of CMC are quite adept at adjusting to the medium and inventing ways to circumvent any shortcomings. In this case, more adaptation appeared to occur within the proximal groups than the distributed ones on valence-related communication qualities, an adjustment that might have reflected these diverse group members' attempts to establish a greater sense of group identity and solidarity over time. By contrast, the asynchronous group remained consistently least desirable in its manner of communicating over time, a pattern that reinforces the need to find strategies that ameliorate the down side of such formats. Contrary to a constructive adaptation pattern, the synchronous distributed group actually showed some declines on the valenced communication measures. Speculatively, the novelty of the tool may have worn off over time, along with the motivation to invest the greater effort needed to achieve effective group deliberations, a speculation to which leaders ought to attend.

Leadership Development

Among the most exciting opportunities we were given was to examine matters of trust and leadership under a truly high task load circumstance. Through the auspices of the Center for the Management of Information and United States Navy Commander Third Fleet, we applied and received approval to participate as one of the few research experiments to be included in the Humanitarian Assistance/Disaster Relief simulation called RIMPAC (Rim of the Pacific) 2000. The exercise involved all branches of the military, the militaries of seven other nations (Japan, Korea, Canada, United Kingdom, Chile, Australia, and United States), and a large number of civilian agencies that provide humanitarian and disaster relief (e.g., the American Red Cross). A component of RIMPAC 2000 was "Strong Angel," which involved developing a refugee camp with United Nations participants, civilian agencies, Marines, Army, and Navy.

The challenge of the Strong Angel Exercise was creating an environment in which two diverse cultures could develop a way of interacting with each other, solving problems, and creating a shared understanding of how work was to be done. In the area of humanitarian assistance, the United Nations and military forces are increasingly required to work together and coordinate activities. The overall objective of this exercise was to create means of collaboration among the various governments and agencies that now attempt to produce a coordinated response in times of natural disasters, refugee evacuations from conflict regions, and the like. The problem is that the UN, military, private government organizations (PVOs), and other nongovernmental agencies (NGOs) operate under different missions and with very different methods. There are large cultural gaps that exist between the military and Human Relief Organizations. The UN is mostly responsible for humanitarian assistance, and their way of accomplishing that mission is to meet in the field and figure out operations in an ad hoc way, to deal with each context differently because it requires new tactics. The military's mission is mostly to save or protect the lives of people who are, or who may be, under siege; to enter an area early, secure it, and exit. How, then, do these two forces gain a shared perspective of what the other side does and what they know? How do they develop trust and understanding? The purpose of this investigation was to assess how the UN, military, and other participating agencies came to understand each side's role in a simulated humanitarian crisis.

In this simulation, the UN, seven participating nations, the branches of the U.S. armed services, and several humanitarian relief agencies attempted to coordinate a response under a scenario in which two neighboring countries are in conflict and refugees must be moved from one country to the next. Over the course of two weeks, fully operational refugee camps were established (complete with volunteer refugees) in a very desolate, "austere" region of the Big Island of Hawai'i (on Parker Ranch), and all aspects of a response to a military conflict or natural disaster were coordinated, including establishment of a Civilian-Military Operations Center (CMOC) to control all the communication and decision-making. Prior to commencement of onshore activities with which we were involved, a CMOC center aboard the U.S.S. Coronado (which is a sea-based battle lab refitted as a communication command center) initiated planning and conducted daily briefings and meetings with another communication center on the ship and with the administrative communication center established on Hawai'i. Altogether, as many as 90 different government and agency representatives participated in these daily communications.

Initial onshore activities included a kick-off social event designed to bring people together FtF so they could become better acquainted. This social gathering included people who had been previously meeting aboard the U.S.S. Coronado en route to the Big Island and people who had not yet been acquainted. Thus, one question we posed was whether this kind of FtF meeting was a productive way of establishing group solidarity and commitment to the same goals. Another part of the exercise included the Civil-Military Operations Center (CMOC), which was established to give both parties an opportunity to learn about events during the day and to update each group on what needed to be done next. The CMOC created a forum where all sides could participate in decision making and to establish a physical place where a dialogue can take place among the Humanitarian Relief Organizations (HROs) and the military.

GroupSystems was introduced in the CMOC meetings as a way to record and capture ideas related to lessons learned from each day. Use of GroupSystems allowed the data to not only be stored, but also aggregated, sorted, displayed, quantified, and printed. Anonymity was activated during the "lessons learned" sessions in the CMOC so as to create an environment in which ideas could be freely shared. One goal for this study was to evaluate whether this anonymous idea sharing would create an environment in which each side could gain greater trust and understand one other better.

Our task was to observe, code, and record the daily communication efforts around the camp and in the CMOC, as well as to interview the participants themselves regarding the communication process, communication tools, quality of decision-making, and success of the collaboration under these extremely high-load conditions. Qualitative analyses, including observations, shadowing, and interviews, as well as survey questionnaires, and note-taking were obtained during the four-day simulation. All GroupSystems output was collected throughout the simulation and during the "hotwash" where all data were presented and lessons learned were again collected electronically.

Field notes, interviews, and observations collected over the course of four days, along with longitudinal transcribed data from GroupSystems, suggested that anonymous idea sharing may have minimized understanding and coordination among the HROs and the military. Needed were other means to build a common vocabulary and to reduces fears of hidden agendas. Because members of the UN teams had had bad experiences previously with news organizations, they entered the activities with misgivings and mistrust of any recorded documentation of the process, something that is not only routine but required for the military. Thus, circumstances in which military leaders must work with leaders from governmental agencies, nongovernmental organizations, and other governments require careful forethought as to how best establish the groundwork for trust prior to any formal meetings. Use of technologies by one organization may seem foreign and threatening to those from organizations with different organizational cultures. In fact, the timing, frequency, and content of formal meetings themselves may be a source of conflict. Leaders from loosely structured and lateral (or "horizontal") organizations, or leaders who have a lot of latitude in how they operate, may chafe at working in an environment of highly scheduled and formal activity that

characterizes vertical organizations such as the military. The ways in which work is to be conducted must be negotiated.

At the conclusion of the simulation, we presented a number of "lessons learned" that were presented in the hotwash. What follows are the assumptions and recommendations that were delivered to the coordinators of the exercise as means for creating trust in exercises calling for decision-making:

A. Preplanning activities
   1. Goal – reduce uncertainty and increase comfort levels. As uncertainty is reduced, participants will perceive less discomfort.
   2. Distribute lists of credentials for participants to view, an agenda, and a short review of accomplishments from previous meetings.
   3. Establish and follow a negotiated, preplanned agenda
   4. Can't assume information sent/distributed is equal to information received/read/understood.
   6. Assign one person oversight and planning duties for meetings and communication.
   7. Create easily distributed guidelines and a mutual glossary and template for participants to use to diminish confusion caused by the use of different jargon.

B. Timing – determine what to share early vs. later
   1. Prioritize information dissemination
   2. Recognize/identify different time orientations, such as attitudes toward timeliness, length and frequency of meetings, use of structured versus informal contacts to resolve problems
   3. Negotiate number, regularity, length of meetings
      Example: fewer meetings preferred so people can get works done but risk coordination and communication problems
   4. Build in redundancy within and across contacts

C. First meeting communication
   1. Agenda-setting – Set an agenda to be easily followed, including tentative time allotments as a means to reduce stress
   2. Medium – don't assume face-to-face is ideal; text or other media may be better for some certain situations
   3. Identify expectations – Who is actually responsible for running meetings? Will meetings be observed and archived for later retrieval and if so, how, and by whom? Avoid negative expectancy violations by clearing up expectations that are likely to be violated
   4. Amount – more communication is not better than quality communication. Consider how to keep meetings concise while still allowing time for nontask social interaction. Meet people first to increase comfort levels
   5. Pace – Keep the meeting moving. Getting stuck on one point may cause participants to become aggravated.
   6. Review accomplishments – Before terminating the meeting, it is important to summarize the accomplishments made by the group because the group will feel a sense of togetherness.

D. Ongoing Communication
   1. Channels – Establish universal communication standard and gear for communication across distances (e.g., cell phone vs. radios)
   2. Technology – Decide when to use technology
   3. Access— Make phone numbers and email addresses available
   4. Language – Create common culture including common vocabulary; minimize use of acronyms

5. Nonverbal communication – Recognize implications of nonverbal behavior for interpersonal relationships (e.g., size and centrality of tents taken as indication of degree of authority or importance)
6. Distinguish between relational messages and poor social skills

This list of basic recommendations for trust building and maintenance can form the basis for leaders developing effective collaborations. Preplanning seems to be the most important part of the meeting because norms should be formed, precautions should be taken for each of the participants, credibility takes form, language is agreed upon, alliances develop, and initial uncertainty about the meeting is reduced. Preplanning creates the possibility of reducing stress and building trust. But preplanning isn't sufficient. The communication patterns of any group need to be monitored in an ongoing fashion and necessary adaptations or interventions planned along the way. All aspects of communication–from when and how often to hold meetings, to how they will be archived, to who are approved participants versus observers, to whether and how distance and electronic communication will be managed–all require coordination and continued attention from someone with such responsibilities. Given highly diverse cultures and communication practices, the potential for collisions in values, rules, regulations, and interpretations remains high and requires serious monitoring so that possible problems can be diffused and so that best practices can be reinforced and retained.

FEATURES AND IMPACT OF TASK LOAD

The concept of "load" is not new; it has been used to reference circumstances in which informational, cognitive, communicative, or physical demands of a situation or task exceed the capacity to perform them effectively or efficiently. Although "information overload" is a commonly used and quite serviceable term that refers to inputs exceeding a system's capacity to process them, we are interested in a broader conceptualization that goes beyond inputs to include difficulties in handling outputs, or performance; one that goes beyond information to include other factors that interfere with processing and performance. Although past efforts to conceptualize load have advanced some rather complex models that attempt to incorporate such features as cognitive resources, system capacity, task difficulty effort, time pressure, fatigue, and motivation (see, e.g., Hancock & Warm, 1989; Hendy, Liao, & Milgram, 1997), the models are themselves perhaps more complex and circular than necessary.

Thus, we turned to a more heuristic approach employing NASA's concept of "task load" as measured by their multidimensional task load index (TLX; Hart & Staveland, 1988). Briefly, task load comprises several nonindependent dimensions that are rated, weighted, and summed to arrive at an overall index of the degree to which a given task imposes a heavy load. These dimensions are (a) *mental demand* (which reflects how much mental and perceptual effort was required and how cognitively exacting and difficult the task was), (b) *physical demand* (which estimates amount of physical exertion required), (c) *temporal demand* (which estimates time pressure felt due to the pacing or demands of the tasks themselves), (d) *effort* (which estimates how hard the person worked physically and mentally to complete the task), (e) *performance* (which captures a subjective sense of how successful and satisfied the person felt about accomplishing the task goals), and (f) *frustration* (which includes feelings of irritation, stress, annoyance, and insecurity or contentment, relaxation, and security). Together, these dimensions cover the wide range of factors often dealt with under such labels as information overload, cognitive load or cognitive difficulty, cognitive busyness, effort, stress, time press, and motivation. The advantage of the TLX approach is that it reflects physical and emotional as well as mental demands and is not just related to information.

A quintessential example of a high-stress, high-stakes communication situation was portrayed in the movie, *Apollo 13*. Faced with failing systems on the space craft, engineers had to first design, under an impossibly short deadline, a new filtering system that the astronauts could fabricate out of materials on hand in their space module and then had to instruct the astronauts how to build it using only audio communication while time was rapidly running out on the life support system. The incredible strain that such crisis situations cause aptly underscores the importance of understanding what factors exacerbate or ameliorate the inevitable communication difficulties that arise under such conditions and avoid the kinds of catastrophic miscalculations, misunderstandings, and flawed decision-making witnessed in such critical incidents as airliner and jet fighter crashes and nuclear plant accidents.

Situations in which degree of task load is likely to be relevant are ones that require ingenuity, mindfulness, and judgmental processes (rather than routine information transmission); that have restricted channels for information transmission; and that entail a serious time-press. It is not a given that higher task load is inevitably associated with negative consequences. Research has long demonstrated that moderate levels of stress or demand may have a beneficial effect on performance. The well-known Yerkes-Dodson law posits a curvilinear (inverted-U) relationship between level of arousal and task performance such that performance is optimal at moderate levels of arousal. Similarly, the Hancock-Warm (1989) model posits that maximal adaptability occurs within a comfort zone that is intermediate between hypo-stress and hyper-stress. Moreover, many day-to-day activities do not require significant cognitive or physical resources for completion. Tasks are overlearned so well that their performance is "run off" automatically. These forms of preconscious automaticity (Bargh, 1997) include reflexive, autonomous responses that do not require

conscious guidance and goal-dependent automaticity, in which the eliciting circumstances are guided by overarching goals but are still enacted without heavy conscious involvement. Presumably, one objective of training is to achieve this high level of proficiency without undue taxation of people's mental, emotional, and physical capacities and in fact to capitalize on moderate levels of arousal to optimize performance.

However, it is possible that new CISs often exceed moderate levels of load, i.e., they move into the level of hyper-stress or overload. Because CISs increase the complexity of tasks; disseminate more, and more diverse, information to yet wider audiences; make instantaneous message and information transmission possible; create numerous interruptions with such things as reminders, alerts, and interactive messaging; speed up the timetables for task completion; and generally "rev up" the pace of work life; they may be culpable in contributing to the elevated stress that personnel are experiencing (Hiltz & Turoff, 1985; Speier, Valacich, & Vessey, 1999) and to decrements in task performance. Prior research has established, for example, that increases in task demands, time pressures, complexity and ambiguity of information, and interruptions usually reduce decision quality and increase task time unless the task is very simple (Cohen, 1980; Schuh, 1978; Shields, 1980; Speier et al., 1999). One reason is that task complexity also requires more complex messages to be constructed and interpreted (Samp & Solomon, 1999). Excessive load may also lead to mindless processing and responding in which people fail to recognize alerting and danger signals or fail to take a more wary stance toward what might be suspicious or invalid information (see, e.g., Burgoon & Langer, 1995). The number and type of cues, in combination with characteristics of the situation, may also affect cognitive load (Hinds, 1997). For example, to make a positive impression in face-to-face interaction often requires a variety of behaviors such as sitting up straight, maintaining eye contact, and using hand gestures. However, when communicating by telephone or e-mail, such impression formation behaviors may be relaxed which, in turn, may reduce workload and allow parties to concentrate on the content of the interaction (Webster, 1997).

Intuitively, excessive task load should also spill over into interpersonal relationships as tempers flare and people engage in online "flaming." The potential impact is a degradation in trust, morale, and performance over the long haul. Yet short term, an opposite problem may arise. Research reveals that another, unexpected byproduct of excess load may be more positive or lenient social judgments. When people are cognitively busy, under time pressure, emotionally aroused, or distracted, they tend to show positivity biases (Paulus, 1991; Paulus, Graf & Van Selst, 1989). The net result of these two trends–reduced task performance and uncritical judgments of group members--may be an inability to make sound evaluations not only of messages and information but also their sources. Humans, as capacity-limited and biased information processors, may be susceptible to mindlessly accepting faulty information and recommendations.

Given that all organizations, the military included, inevitably will increase their reliance on CISs to conduct routine and nonroutine business, these possibilities argue for deeper exploration of which CISs should be employed and when, and for discovering what communication strategies or tools can be adopted and adapted to mitigate any damaging effects while realizing the extraordinary benefits that CISs also bring. The investigations conducted under the current contract addressed these issues.
Nine experiments, reported next, systematically altered various forms of task load while distributed team members conducted tasks under synchronous or asynchronous forms of communication that varied in degree of modality richness. Two field experiments complemented these studies by providing a theoretical and descriptive explanation of what leaders in virtual teams do to produce collective knowledge and maintain trust as a foundation for accomplishing the team's mission effectively and on time. Given the compressed time in which army units must gather information and carry out their tasks, we were especially interested in teams' ability to detect critical information in a pool of irrelevant and inauthentic messages. Further, this research tested the effect of early trust-building in FtF and electronic contexts to determine how initial levels of trust affect the over-time communication patterns and ability to develop trust when

teams are no longer physically co-located. Finally, we tested various training strategies whereby leaders can improve performance in distant teams communicating electronically.

CURRENT INVESTIGATIONS

Experiment 1: Effects of Time Pressure as Task Load

The time constraints that teams face influence their information processing, as team members must choose, often implicitly, which information to focus on, for how long, and at what depth. Features of CISs themselves affect time press. For example, it takes considerably less time to discuss information—to say and hear it—than to type it into a computer. Not only does typing require more time, but it uses different resources than does verbal interaction, including a more explicit editing process, as well as reading and understanding the replies of one's interlocutors. We reasoned that the effect of time constraints might be moderated by features of CISs. When there is an abundance of time, information processing and communication processes that accompany them might be relatively unaffected by the communication medium through which the interaction takes place. However, when time is of the essence, communication processes and task performance might be especially vulnerable to influences of the communication medium.

The first investigation, reported in Stoner and Burgoon (2003), examined time pressure as a moderator of the effect of communication technology on communication processes and outcomes. The variables of interest are shown in Figure 2, which calls attention to the specific affordances, communication qualities, and outcomes being examined.

Hypotheses. The rationale underlying the study was that information processing requirements differ across communication formats. Synchronous and asynchronous text interfaces require participants to type and read information compared to voice transmission in audio-based formats. The first two hypotheses addressed modality differences. H1 posited that *compared to mediated formats (audio and audio-visual), FtF communication results in higher relational and interactional communication quality of (a) involvement, (b) feelings of mutuality, (c) interaction coordination, (d) communication appropriateness, (e) spontaneity, (f) positivity, (g) composure, and (h) evaluation.* H2 posited that *compared to visual formats, audio-only communication produces higher task-related communication quality by increasing (a) dominance, (b) communication appropriateness, (c) positivity, and (d) task evaluation.*

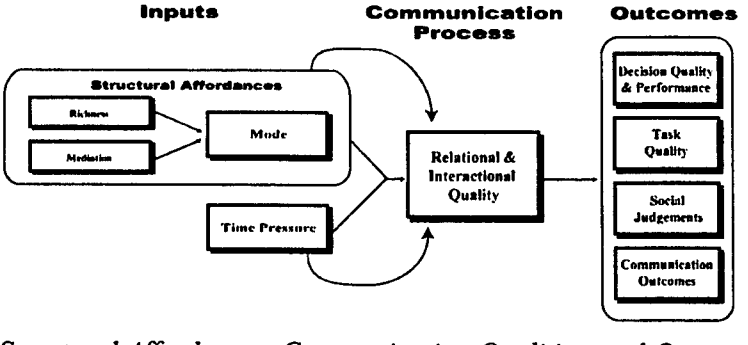


Figure 2. Model of Structural Affordances, Communication Qualities, and Outcomes

Tasks vary on how much time teams have to complete them. Under time pressure, communication should become *more efficient, less rich in detail, more spontaneous* (i.e., less planned), *more task oriented,* and characterized by *more attempts to dominate interaction*. H3 tested this set of predictions. Finally, we expected that audio-based communication would elicit more interactivity and desirable communication

qualities under conditions of moderate time press. Thus, H4 posited that *time pressure curvilinearly affects communication quality such that relative to low and high time pressure, moderate time pressure produces the most (a) involvement, (b) mutuality, (c) interaction coordination, (d) appropriate communication, (e) expected communication, (f) positivity, (g) composure, (h) favorable evaluation,* and *(i) decision-making effectiveness.*

Sample and Method. Participants (N = 146) were undergraduate students in communication and business classes who received extra credit for participation. They were randomly paired with unfamiliar others to form two-person teams. The experiment employed a 3 (time pressure: low, moderate, high) x 3 (communication modality: FtF, audio, audiovisual) factorial design. In the FtF condition, team members were seated facing one another, with separate computer terminals available nearby to complete written materials. Participants in the mediated conditions reported to separate locations and interacted via the Microsoft NetMeeting program with either audio-only or full audiovisual access enabled. Teams worked together on two tasks. The first was a "get acquainted" exercise in which participants were given a set of topics to discuss. We chose neutral topics, ones that participants would feel comfortable talking about and that would have no right or wrong answers (e.g., "Who is the most important person in your life").

This task familiarized team members with one another's communication style, as well with the communication technology (where applicable) through which they interacted. The second task was a decision making exercise based on the series of business case studies developed by Moberg and Caldwell (1989). The exercise presents the description of an organizational or business problem, then asks participants to work through a series of steps to solve it. The outcome of interest was the number of steps participants use to complete the problem, with fewer steps indicating efficient decision making. Teams were informed that they had 20 (low), 15 (moderate) or 10 minutes (high time press) to complete three cases and that the task usually took 20 minutes to finish. An electronic stop watch visible on the computer screen served as an explicit and constant reminder of time remaining. A ping sound signaled when time had expired.

After each case study, team members completed the Task Load Index. At the conclusion of these case studies, team members rated the quality of partners' communication measured on 13 dimensions of communication quality, including interactivity and pleasantness. Other outcomes measured included decision-making effectiveness and members' ratings of one another on trust and credibility.

Results and Implications. Communication qualities were grouped into two clusters, one related to task completion and one related to social relationships. Audio and FtF communication emerged as superior to video communication on virtually all communication qualities, and audio scored the highest of all three modalities on several measures (see Figures 3a and 3b). Audio communication was seen as the most involving of the three and as providing richer yet more efficient, task-focused, and analytical information exchange than video communication. It was also seen as more appropriate and positive in tone and rated highest among the three CISs on task discussion effectiveness. Along with FtF interaction, it created better interaction coordination.

Time pressure also made a difference: the higher the pressure, the less rich and analytical the communication, but also the greater the coordination. Moderate time pressure was best for keeping tension and pleasantness at an optimal level (see Figures 4a and 4b). However, time pressure degraded decision-making effectiveness, especially in the audio condition (see Figure 5). This finding suggests that with increased time pressure comes the need for more visual cues to coordinate task performance and gain feedback. The various modalities were equally effective in establishing and maintaining trust.

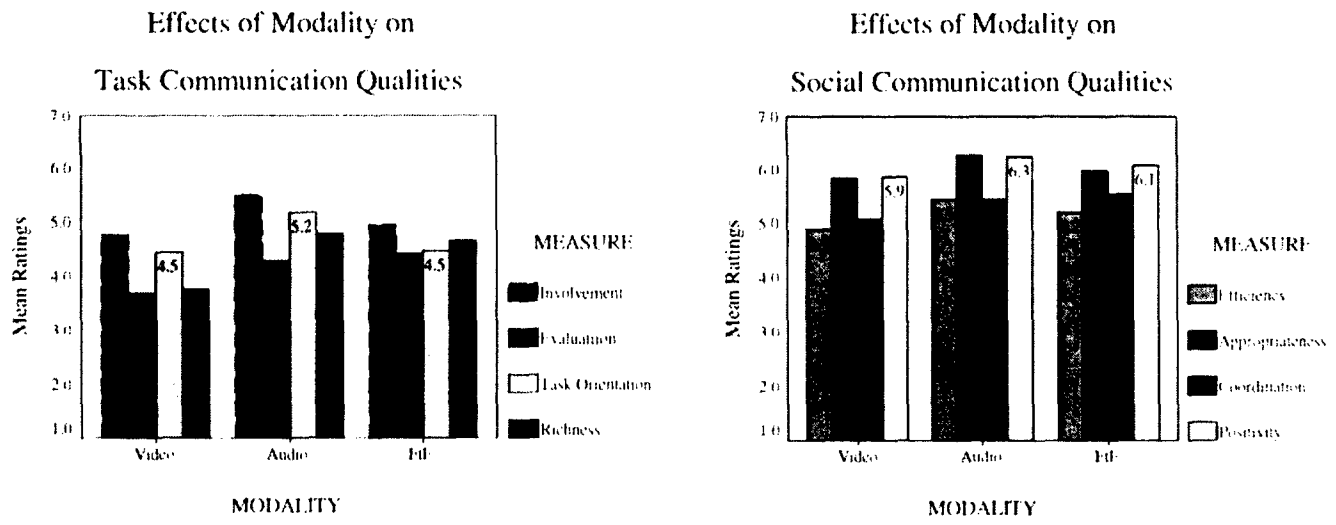


Figure 3. Effects of Modularity on (a) Task-Related and (b) Social Communication Qualities

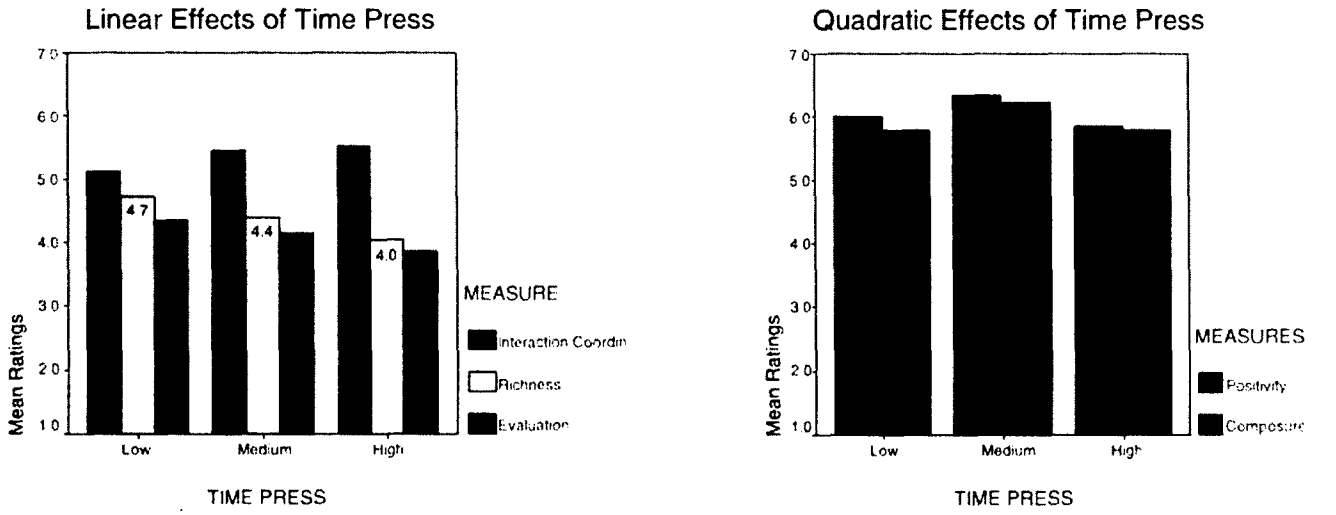


Figure 4. Linear and Quadratic Effects of Time Pressure.

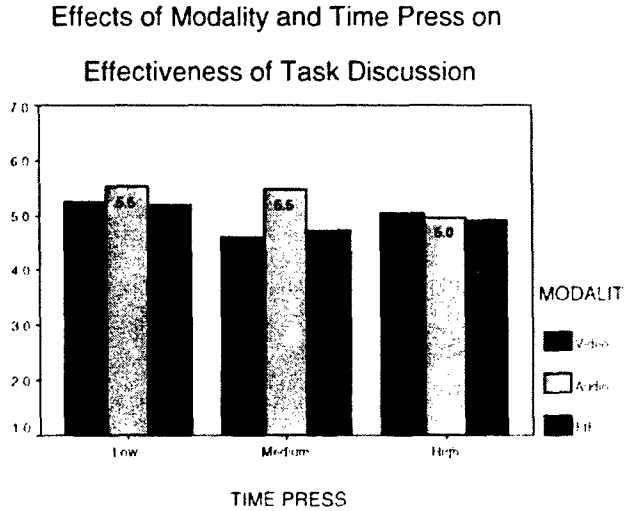


Figure 5. Effects of Modality and Time Press on Rated Effectiveness of Task Discussion.

Overall, these results imply that as long as task load is modest, leaders would gain benefits from using cell phone and teleconferencing forms of communication rather than broader bandwidth modalities, but they should expect process and performance losses if time pressure becomes excessive.

Experiment 2: Effects of Information Validity as Task Load

The second experiment, reported in Burgoon, Stoner, Bonito, and Dunbar (2003), entailed a "get-acquainted" task during which half of the teams had a member who gave deceptive answers. This was considered a form of task load in that naïve partners needed to be alert to receiving invalid information relative to those whose partners were truthful. Team members discussed four topics intended to promote personal communication. Communication took place FtF or via one of three CMC modalities: text, audio, or audiovisual (AV). The same interactivity were used as in Experiment 1. The trust measures included all aspects of credibility that might influence trust in another's veracity and performance. Additionally, team members assessed the truthfulness of partners' responses during a first task.

Successful collaboration and teamwork often depend on the manner in which participants exchange and process information. Although many reasons are given for the failure of teams or groups to pool and process their information resources, one often overlooked factor is that members may have reasons to withhold or distort information. Team members may wish to conceal their lack of knowledge, have hidden agendas, possess information they do not wish to share with others, or have other vested interests that result in introducing false, faulty, or misleading information. Under such circumstances, widely held presumptions about the trustworthiness of group members and the truthfulness of their communication are no longer valid. In principle, the presence of invalid information should add a level of cognitive difficulty to any task because of the need to devote greater cognitive resources to analysis, interpretation, and evaluation of such information.

What happens to trust when such work is technologically mediated becomes an interesting and potentially paradoxical one. Our work and that of others has shown that distributed work yields weaker interpersonal relationships and less trust than does co-located and face-to-face work (e.g., Burgoon, Bonito & Kam, in press; Griffin, Patterson & West, 2001). Paradoxically, a diminution in trust may carry with it greater skepticism and the hence, greater capacity to detect faulty information. Alternatively, social identity deindividuation theory predicts that distributed collaborations promote group identity (Tidwell & Walther, 2002), which should bolster faith and trust in the group, and hence, lowered recognition of faulty information. In Experiment 2, the task teams undertook was ostensibly to get acquainted with one another. But the outcomes we were interested in were the degree of trust that developed and accurate detection of deceptive information. It was our expectation that communication modality and task load together would affect degree of interactivity, resultant trust, and task performance.

As argued previously, the principle of interactivity postulates that the degree of interdependent, contingent, participative and synchronous interaction afforded by a communication interface systematically and substantially affects communication processes and outcomes. When faulty information is neither highly probable nor actively introduced, i.e., when interaction is routine and team members are not experiencing additional cognitive taxation beyond what a task normally entails, then the more they become engaged in the interaction and establish mutuality, the more likely they should be to achieve coordinated, synchronized, and effortless interaction contributory to trust and high mental functioning. Our research (Burgoon, Buller & Floyd, 2001) has shown that trust is higher under FtF than CMC, and should produce more favorable attributions about another's sincerity and honesty. Among CMC modalities, there is also evidence that the auditory channel has unique advantages relative to text (Jensen, Farnham, Drucker, & Kollock, 2000; Stoner, 2001). It synchronizes and paces interaction in a way that sustains involvement and facilitates comprehension, it makes available feedback about a receiver's understanding and reactions, and through turn-taking mechanisms, creates a coherently threaded discourse. Because both audio and AV modalities

include oral speech, the organizing, pacing, and information-processing properties of the voice may confer benefits on both of these CMC modalities, although there is some reason to believe that removing visual distractions may actual promote more personalized, "hyperpersonal" communication than when visual cues are present (Walther, 1996). Thus, under CMC conditions, when vocal cues are available, trust and detection of invalid information should be higher than when they are absent, and a voice-only condition may actually be superior to full audiovisual access.

Conversely, when task load is elevated by virtue of the presence of invalid information, ability to detect such information should be impaired, especially under the very conditions most likely to foster interactivity. Mutuality and involvement contribute to leniency and truth biases in making judgments of another's credibility. With truth bias comes lowered accuracy in detecting deceptive information because telltale indicators are overlooked, ignored, or discounted in favor of believing the person is telling the truth. So, all else being equal, conditions that create the highest mutuality should be the worst for detecting deceit. In FtF contexts, deceivers have been shown to deliberately and successfully modify their performances over time, in part because they respond to any observed skepticism on the part of receivers by working harder to appear normal, engaged, and pleasant. If mediated communication attenuates not only the sense of mutuality and level of involvement but also the total available amount of feedback, then mediated forms of communication may mitigate some of the truth bias and inaccurate deception detection found in FtF interaction.

Moreover, appraising information under FtF interaction may be more taxing than under mediated formats because of the number of verbal and nonverbal channels and features needing to be assessed. Among mediated formats, those that foster the greatest mutuality–video and audio--should create the highest trust and truth biases. By contrast, text should minimize the demands on perpetrators of deceit. With fewer channels to manage, more time to plan and edit messages, and fewer chances for channel discrepancies that might reveal their ulterior motives, deceivers should have the greatest opportunity to put forth a credible front. Deception detection, then, might be the least accurate under text conditions for receivers untrained in the subtle, inadvertent deception indicators available in text.

Finally, although senders do attempt to control the verbal and nonverbal features of their deceptive communication, they are commonly less prone to monitor and successfully manage their voice than their face and body, so the audio channel may include telltale signs that elicit suspicion from receivers and heighten attention to their messages. Thus, among mediated conditions, receivers may be most successful at detecting deceit when using audio-based formats (such as cell phones and audio-conferencing) and least successful when communicating via text.

Hypotheses. In the experiment to be reported, participants completed a discussion either FtF or under one of three distributed, mediated conditions. In addition, dyads were randomly assigned to either a high task load (faulty information present) or low task load (no information manipulation) condition. In the former, one of the team members was instructed to provide deception information to the other, whereas participants in the latter condition were simply allowed to act normally. If the principle of interactivity holds, and visual and auditory nonverbal cues provide for richer interactions characterized by high involvement and mutuality, then the conditions most favorable for involvement and mutuality should move from text (least) through audio and AV to FtF (most). Because the special properties of oral communication–e.g., interactional synchrony, pressure to tightly link conversational turns, greater message comprehension, and rapid exchange of information--may be sufficient to overcome any deficits from losing visual cues, we left as a research question whether the AV modality affords more interactivity than the audio-only condition. Thus, we hypothesized that *involvement and mutuality are greatest under FtF communication, followed by AV and audio forms of mediated communication, and lastly, text.* Given our stance that modalities merely create favorable or unfavorable conditions for involvement and mutuality to materialize and that it is these communication properties of interactivity that are truly responsible for resultant outcomes; and, given our

previous findings that higher involvement and mutuality are associated with more favorable social judgments, we further hypothesized that *trust and truth estimates are positively correlated with involvement and mutuality.*

It follows that under low load conditions, trust and truth estimates should increase as one moves from text to audio and AV to FtF modalities. However, adding faulty information to the mix may modify this rank-ordering because the diagnosticity of deception indicators available in the text and audio channels should partially offset the interactivity effects. Thus, under high load conditions, trust, truth estimates, and truth bias should be greatest in the FtF condition followed by the AV and then the text and audio conditions. This task by modality interaction is reflected in the next two hypotheses. Under low load conditions, we would expect all estimates to be in the upper end of the spectrum based on a combination of the actual veracity of the messages and the truth bias: *Under low load conditions, trust and truth estimates are (a) higher under FtF than mediated communication and (b) higher under AV and audio than under text communication.* By comparison, we expected that when faulty information is present, there would be more accuracy in the audio than the AV condition. Consequently, the last hypothesis was worded in terms of truth bias: *under high load conditions, trust and truth biases are (a) higher under FtF than mediated communication and (b) higher under AV than audio and text communication.*

Sample and Method. Participants (N=128) were undergraduate students, recruited from a mass-lecture communication course, who received extra credit for their participation. They were paired to form 64 same-sex dyads. The experiment was a 2 (task load) x 4 (modality) design with cells balanced by gender. The four modalities consisted of (1) FtF, (2) text, (3) audio, and (4) AV communication. In the text condition, teams communicated via the chat window in Microsoft NetMeeting. In the audio condition, voice communication was enabled and the video link was disabled. In the video conditions, two small windows presented the participants with a view of their partner and and image of themselves being transmitted. Task load was manipulated by randomly assigning team members to the role of Person A or Person B and high or low load conditions. Within the high load condition, Person A was instructed to withhold relevant personal information or give untruthful, misleading, vague, and/or evasive responses in the upcoming discussion. It was expected that this kind of information manipulation would prove more cognitively taxing for Persons B than straightforward presentation of information. Persons B received no special instructions.

The task was the same "get-acquainted" social task as in the previous experiment. The four topics discussed were, "tell about the most significant person in your life," "tell about a mistake you made recently," "talk about responsibility," and "describe the most unpleasant job you ever held." At the conclusion of these 10-minute discussions, everyone completed a Web-based questionnaire then proceeded to conduct a second, decision-making task which consisted of an interactive management case study on employee motivation. No task load manipulation occurred during this task. Afterward, team members again completed a Web-based questionnaire, were debriefed and thanked. The questionnaires measured perceptions of the partner's involvement, receptivity, similarity, understanding, and connectedness during the interaction; judgments of the partner's credibility in terms of trust, expertise, composure, persuasiveness, dominance, and sociability; and estimates of the partner's truthfulness on the four topics. To further measure how well naive team members picked up on the information manipulation by their partners, Persons B also rated Partner A information management.

Results. Communication process measures are typically highly intercorrelated and more parsimoniously understood as a set of interactivity indicators. The first two hypotheses were tested on sets of measures to determine if they collectively showed modality and task load effects. Analyses were conducted on ratings taken immediately following the get-acquainted task and also at the end of the session, after completing the decision-making task. The latter measures ascertain persistence over time. An effect for time showed that involvement and mutuality generally increased over time in all conditions except text (which remained flat). For media in which nonverbal cues were available, more interaction over time resulted in greater feelings of

involvement, connection, receptivity, understanding, and similarity. As for modality effects, they showed significant differences regardless of whether measured immediately after the first task, after the second task, on in a combined analysis. Results were significant for all five interactivity measures. Figure 6 shows illustrative patterns measured at the end of the two tasks (see also Table 1 for means). Consistent with H1, moving from text to audio to audiovisual to FtF modes of communication yielded respective increases in the interactive qualities of involvement and mutuality. More specifically, FtF interaction created more involvement and felt understanding than the mediated conditions; the audio and AV conditions created more involvement, felt understanding and connectedness than the text condition; and the AV condition produced more connectedness and perceived similarity than the audio condition. Throughout, text earned the lowest ratings, consistent with the hypothesis.

The second hypothesis, that high cognitive load adversely impacts interactivity, was supported. As seen in Figure 6, the presence of faulty and invalid information lowered interactivity, especially in terms of involvement, felt understanding, and perceived similarity (see Table 1 for all means). These effects persisted through the second task, even though the information manipulation did not continue. Thus, one might expect cognitive load to have "legs" in terms of carrying over to low-load situations.

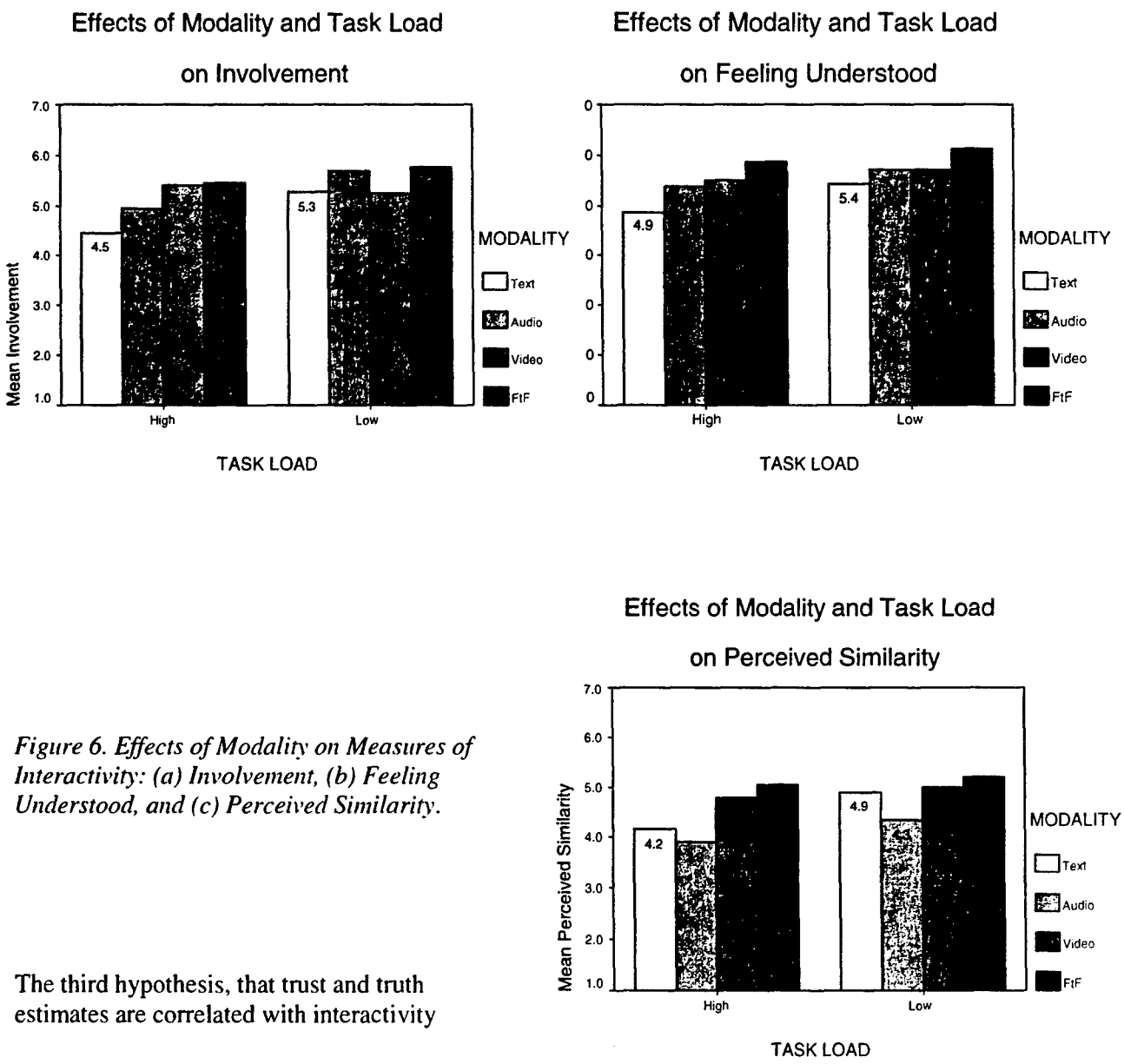


Figure 6. Effects of Modality on Measures of Interactivity: (a) Involvement, (b) Feeling Understood, and (c) Perceived Similarity.

The third hypothesis, that trust and truth estimates are correlated with interactivity

measures, was strongly supported. All correlations were positive and with medium to large effect sizes. Separate from the influence of communication modality, whenever team members generated higher degrees of involvement and mutuality, their trust and related credibility judgments also ended up being higher. Conversely, whenever involvement and mutuality suffered, so did trust and credibility among team members.

The last two hypotheses, concerning the impact of cognitive load on trust and judgmental accuracy, were tested on Person B data only, inasmuch as half of those in the Person A role were deceivers. Regarding the six measures related to trust, modality exerted a significant effect, especially on the measures of expertise and composure (see Table 1 for means). Participants were seen as having higher expertise in the FtF than other modalities, and lowest composure in the text modality. Although task load did not interact with modality, the pattern of the relationship on the trust subscale warranted further probing. Simple effect tests within each modality revealed that within the audio modality, trust was significantly higher under low than high load.

Analysis of the four truth estimates yielded a similar (and significant) pattern: Naive team members judged their partner to be more truthful under audio and AV modalities than text and under low load (faulty information not introduced) than high load (faulty information introduced) within both the audio and AV modalities (see Figure 7). Comparatively, those in the text condition actually estimated higher truthfulness when bad information was introduced than not, indicating that they were highly misled by such information. These results argue in behalf of the audio and AV modalities enabling more accurate judgments. Although the audio condition was not statistically more accurate than the AV condition, the larger difference between high and low load conditions in the audio than the AV condition are at least suggestive of greater accuracy in the audio condition.

Finally, analysis of the information management questions revealed that naive team members rated their partner's communication as more informative, complete, definitive, precise, clear and straightforward in the low load (truthful) than high load (deceptive) condition. Put differently, they recognized the manipulation of information toward incompleteness, vagueness, and evasive in the high load condition. Some of these patterns varied by modality. Text and audio messages were see as particularly uninformative and imprecise, relative to FtF and AV messages, in the high load condition.

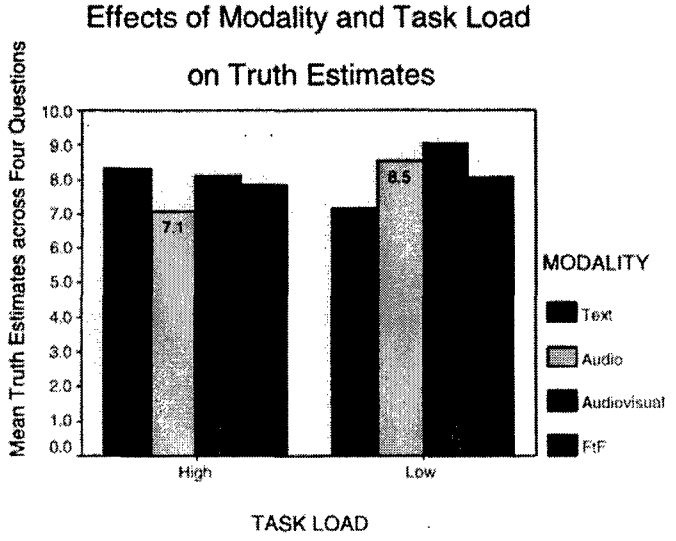


Figure 7. Effects of Modality and Task Load on Truth Estimates.

Discussion and Implications. This investigation confirmed again that communication formats vary in the degree of interactivity they elicit and that interactivity is strongly related to whether team members trust one another, hold one another in high esteem, and perform tasks successfully. Because involvement and mutuality are associated with more favorable judgments of team members' trustworthiness, sociability, expertise, composure, persuasiveness, and dominance, fostering interactivity can be the key to achieving team morale and cohesiveness. Mediated forms of communication are less likely to foster high involvement and mutuality (i.e., interactivity), and text communication, which at the time of this writing, remains the most common electronic medium, is least likely to do so. Thus, a challenge for leaders utilizing text communication is to compensate for decrements in interactivity when high interactivity is desired. Those circumstances include situations where trust and credibility are to be encouraged and reinforced.

Adding to the challenge of establishing high interactivity under electronic forms of communication is task load. High task load adversely affects interactivity. Team members feel less involvement and mutuality when cognitive load is elevated due to the presence of faulty and invalid information. However, in circumstances such as this, reduced interactivity may be the desired outcome, because what is needed is more skepticism and less, not more, trust. When information processing demands are high, when more thoughtful and dispassionate deliberation is needed, too much involvement and mutuality may be counterproductive.

In the current case, naive team members recognized that information was less complete, precise, clear, and straightforward in the high load (faulty information condition). Yet trust under high load was lower only in the audio condition, and truth estimates discriminated between low and high load only in the audio and AV modalities, suggesting that these are the modalities in which team members are most attuned to the possibility of questionable information being presented by their team members, especially when such information relates to personal and social information (as the discussion task did). That such awareness was not evident in the text and FtF conditions indicates that modalities vary in enabling high-quality information processing by users.

The tendency in the text condition to see faulty messages as more truthful than actual truthful ones is concerning. In combination with the other results in the text condition, the lower accuracy with text raises questions about the advisability of over reliance on text interfaces, particularly when careful scrutiny of information is needed. Thus, the implication for leaders is to avoid text communication when sensitive and subtle information must be gleaned and analyzed or when hidden agendas and ulterior motives might bias the information being presented. Absent the option to avoid text communication, successful leaders must look for means to mitigate both the decrements in interactivity and the poorer judgments that attend text communication, both of which can lead to poorer team performance.

Experiment 3: Effects of Information Validity as Task Load, Replication

Hypotheses. It was possible that the results from the preceding experiment were partly a function of the task in which team members engaged. Consequently, we chose to replicate the experiment with another task, again utilizing our revised version of the familiar Desert Survival Problem, in which team members must rank-order salvageable items from their overturned jeep in terms of survival value. Hypotheses remained the same as before.

Table 1. Means and standard deviations for interactivity, trust, and truth estimate measures.

Means and Standard Deviations of Ratings of Persons A by Persons B

		TASK LOAD					
		Low		High		Total	
	MODALITY	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Involvement	Text	5.39	.99	4.76	1.15	5.16	1.08
	Audio	5.59	.83	4.87	.70	5.25	.84
	Audiovisual	5.33	.57	5.40	.89	5.37	.74
	FtF	5.56	1.08	5.33	1.08	5.45	1.07
	Total	5.46	.88	5.12	.97	5.31	.94
Connectedness	Text	2.93	.98	4.29	1.12	3.56	1.24
	Audio	4.00	1.31	4.04	1.16	4.02	1.21
	Audiovisual	4.15	1.13	4.81	1.32	4.53	1.26
	FtF	3.63	1.23	3.92	1.12	3.78	1.16
	Total	3.66	1.23	4.32	1.22	4.00	1.26
Receptivity	Text	5.49	1.15	5.50	1.00	5.49	1.08
	Audio	5.88	.89	5.44	.56	5.68	.78
	Audiovisual	5.44	.83	5.80	.94	5.63	.90
	FtF	5.79	.84	5.66	.79	5.73	.80
	Total	5.64	.94	5.62	.83	5.63	.89
Homophily	Text	4.44	1.13	4.28	1.38	4.38	1.21
	Audio	4.38	1.02	3.80	1.13	4.11	1.09
	Audiovisual	4.66	.92	4.48	1.57	4.57	1.28
	FtF	4.97	1.24	4.23	1.02	4.64	1.19
	Total	4.61	1.09	4.21	1.30	4.43	1.20
Felt Understanding	Text	5.43	1.06	5.07	1.12	5.30	1.08
	Audio	5.77	.82	5.43	.62	5.61	.74
	Audiovisual	5.52	.46	5.61	.95	5.57	.74
	FtF	5.78	.91	5.71	1.03	5.75	.95
	Total	5.62	.85	5.48	.95	5.56	.90
Trust	Text	5.36	1.07	4.98	1.18	5.22	1.11
	Audio	5.89	1.04	5.11	1.11	5.53	1.13
	Audiovisual	5.56	.78	5.72	.64	5.64	.71
	FtF	5.39	.96	5.48	1.02	5.43	.97
	Total	5.54	.97	5.36	1.00	5.46	.99
Sociability	Text	5.85	1.09	5.33	1.87	5.66	1.43
	Audio	6.41	.74	5.11	1.24	5.80	1.19
	Audiovisual	5.68	1.54	6.06	.97	5.87	1.27
	FtF	6.14	.90	5.73	1.46	5.95	1.19
	Total	6.01	1.12	5.60	1.40	5.82	1.26
Expertise	Text	4.86	.87	4.60	1.17	4.74	1.01
	Audio	5.03	.90	4.22	.91	4.62	.98
	Audiovisual	5.12	.83	4.83	.99	4.95	.92
	FtF	5.45	.99	5.55	.83	5.50	.89
	Total	5.11	.90	4.82	1.06	4.96	.99
Dominance	Text	4.60	.97	4.68	.81	4.64	.88
	Audio	5.07	.97	4.33	1.05	4.70	1.06
	Audiovisual	4.68	.60	4.99	.78	4.86	.72
	FtF	4.92	.94	4.89	1.22	4.90	1.07
	Total	4.80	.88	4.76	.97	4.78	.92
Composure	Text	5.43	1.15	5.04	1.13	5.25	1.14
	Audio	5.83	.96	5.25	.75	5.54	.89
	Audiovisual	5.98	.81	5.89	.84	5.93	.82
	FtF	5.94	.77	5.92	1.00	5.93	.88
	Total	5.78	.94	5.57	.98	5.67	.96
Persuasiveness	Text	4.71	1.05	4.31	1.21	4.53	1.12
	Audio	4.97	.76	4.08	1.16	4.53	1.06
	Audiovisual	4.54	.87	4.89	1.38	4.74	1.19
	FtF	4.92	1.21	4.77	.95	4.84	1.06
	Total	4.78	.97	4.56	1.22	4.66	1.11
Truth Bias	Text	2.18	3.04	3.33	1.91	2.69	2.62
	Audio	3.52	1.81	2.07	2.33	2.74	2.19
	Audiovisual	4.08	.88	3.13	1.44	3.52	1.31
	FtF	3.06	2.15	2.85	2.08	2.95	2.08
	Total	3.17	2.23	2.85	1.94	3.00	2.08

Sample and Method. Participants (N = 254) were undergraduate male (49%) and female (51%) students who were randomly assigned the role of Person A (who would become a confederate) or Person B (hereafter, the naive team member), to a modality, and to a task load condition. Task load was high (faulty information introduced) or low. Modalities included FtF, text, audio, and AV. Teams received via computer the description of the Desert Survival Problem and a document entitled, *Imperative Information: Surviving in the Desert,* that provided detailed information relevant to the task. Team members individually rank-ordered the 12 salvage items, after which Persons A received the task load induction, which consisted of instructions to present bogus information and arguments opposite to what the experts had advised in the document on desert survival. They were to use any and all manner of deceit to advocate: (a) leaving the jeep and taking along equipment needed to find their way, (2) not relying on devices like the rearview mirror and flashlight for communication, and (3) shedding all unnecessary clothing (e.g., rain-gear) to make walking easier. Teams then commenced discussion of the task, their proposed rankings, and their reasons for their rankings. Afterward, team members individually re-ranked the 12 items and completed the same measures of trust and credibility as used previously. For Persons B, scores were calculated for quality of final decision, based on degree of correspondence to or deviation from the experts' rankings, and for degree of influence exerted by the partner, based on change from pre- to post-discussion rankings.

Results and Implications. In this experiment, modality did not directly affect the communication process but task load did. Higher load (presence of deceptive information) significantly reduced involvement and mutuality, eroded trust, and adversely affected other credibility assessments (see Figures 8a and 8b). As might be expected, the presence of deceptive information also led to poorer decision quality. Correlations among interactivity, trust, and decision quality revealed that reductions in involvement and trust were associated with poorer decisions in the high load (i.e., deceptive) condition.

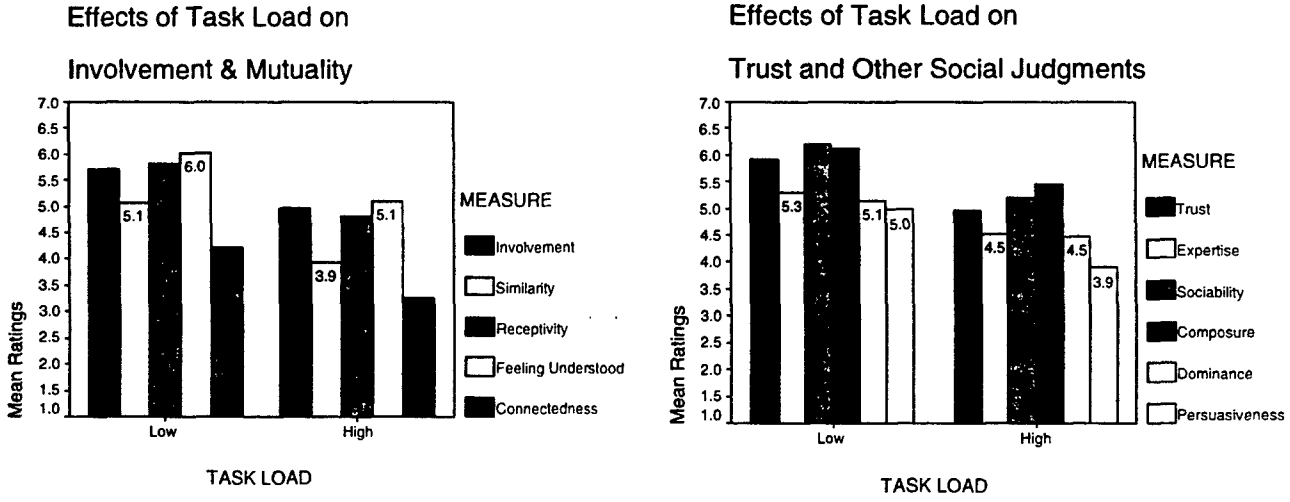


Figure 8. Effects of Task Load on (a) Interactivity and (b) Social Judgments.

One implication of these findings is that communication processes "register" invalid information, even if at an unconscious level, by producing less involvement, mutuality, trust, and credibility among team members. For leaders, these results strongly endorse the relevance of interactivity to team communication and outcomes. Reductions in interactivity and trust may be symptomatic of faulty information or ulterior motives present in the team and serve as a red flag to leaders. Decrements in interactivity also might be considered advantageous in terms of creating greater detachment and reducing unwarranted trust in bad information or deceptive team members. However, reductions in interactivity and trust did not yield

corresponding improvements in information processing and analysis. This creates a conundrum for leaders– to opt for less interactivity, in hopes of increasing skepticism and mindful information processing, or more interactivity, in hopes of final decision outcomes benefitting from greater mental and communicative engagement. The current results demonstrate that greater detachment does not translate into critical thinking. Additional strategies must be used to ensure that reductions in involvement and mutuality do not simply dampen alertness, careful evaluation of relevant information, and commitment to the team. Leaders must be on the look-out for these potentially unintended consequences and prepared to take corrective actions to mitigate damage to team performance.

A follow-up analysis of these last two experiments considered which CISs are expected and which ones are positively or negatively evaluated. FtF communication was rated as the most expected and positively regarded modality, in part because achieving mutuality and smooth, coordinated interaction is easier with FtF communication. However, the CMC conditions were also well-regarded when task load was low. The implication is that if leaders and team members can manage to keep involvement up and achieve interactions that are smooth, coordinated, and useful, then any CMC modality can be used effectively under routine (low load) conditions.

Experiment 4: Effects of Information Complexity as Task Load

Team performance is often related to information processing requirements inherent in a given task. In some cases, information is unambiguous, well organized, and fairly comprehensible, which reduces the amount and degree of information processing necessary to solve a problem. In other cases, information is complex, less organized, and less comprehensible, which likely increases processing demands. Such demands are likely to affect communication process, as participants must devote considerable interaction effort to digest, collate, and understand the inferences contained in complex and unorganized information. The picture becomes more complicated, however, if such interaction is conducted via communication technologies, as some formats provide better opportunities for data management than do others.

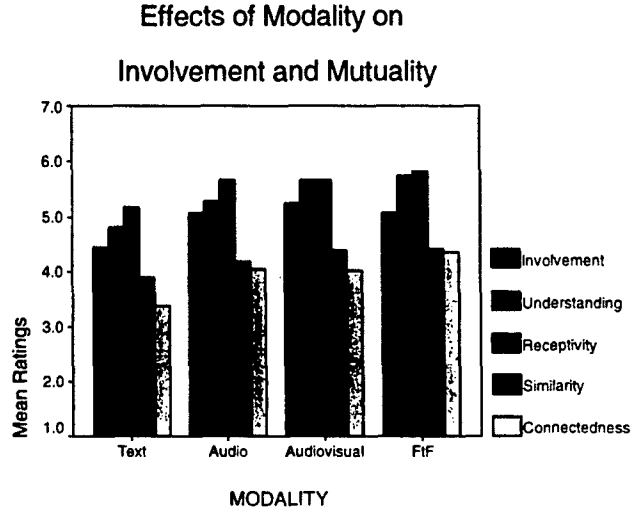
Hypotheses. This next experiment manipulated task load in the form of information complexity and the presumed demands it would place on cognitive resources. In line with previous theorizing and some of our prior results, we continued to expect that communication modalities would differentially affect interactivity such that *involvement and mutuality are highest under FtF, then audiovisual and audio, then text communication.* We also expected communication processes and outcomes to be differentially affected by communication modalities when information was complex. Because complex information requires more sophisticated and lengthy processing, and leaner environments make the processing of information more difficult than in richer environments, we expected richer environments to be more efficacious for effective communication, trust, credibility, and decision-making. Thus, we hypothesized an interaction between task load and modality such that *FtF and audio modalities produce higher involvement, mutuality, trust, credibility, and decision quality when information complexity is high relative to when it is low.*

Sample and Method. Teams worked on the previously described Desert Survival Problem, with one significant change. Before engaging in problem solving interaction, team members read either a low- or high-load version of the *Imperative Information: Surviving in the Desert* document. To create an effective manipulation of task load, we first conducted a pilot test in which we created four different versions of information about surviving in the desert, and participants (N = 60) conducted the ranking task individually. Based on those results, we selected the two versions that differed the most. The low-load version had a 12th grade readability level and moderate level of linguistic complexity, whereas the high-load version was written using far more technical jargon and details from a military field manual. It had a college level readability score and more complex vocabulary.

Participants in the main experiment (N = 128) were communication and business students. Two-person teams were assigned to one of the eight possible combinations of information complexity and communication modality derived from the 2 (information complexity: high, low) x 4 (communication modality: face-to-face, text-only, audio-only, and audio-visual) factorial design. Procedures and measures were the same as described previously. The TLX measure was included as a check on the load manipulation, and task discussion effectiveness was included to tap participants' perceptions of task performance.

Results. Modality affected all communication measures. As expected, involvement and mutuality were lowest with text communication (see Figure 9). Team members were also judged as the least sociable, competent, and dominant under text and the most so under FtF and AV. However, trust did not differ across modalities.

Figure 9. Effects of Modality on Interactivity Measures.



Unexpectedly, the high information complexity condition did not create uniformly higher perceived task load than the low complexity information. Adverse effects from high task load depended on what form of communication was used. Whereas with audio and text communication (the two modalities lacking visual cues), the high-load technical information created greater effort, with FtF and AV communication, the high-load technical information made the task seem less effortful than the low-load version. The higher load version also created greater trust, perhaps because the team members who used it seemed more knowledgeable. Task discussion effectiveness was rated highest under the combination of audio and low task load.

Finally, a follow-up analysis on the expectedness and evaluation of the four different modalities revealed that FtF and audio modalities were most expected and favorably regarded, qualifying communication in those modes as positive expectancy confirmations. The AV condition was clearly novel, earning the lowest ratings on expectedness but still relatively favorable evaluations as a modality. It constituted a positive expectancy violation. By contrast, the text modality earned the lowest ratings on the valence dimension and low ratings on expectedness, making it a negative expectancy violation (see Figure 10).

Discussion and Implications. Information complexity should be a salient issue for leaders in terms of choosing an appropriate communication format. As text was the least desirable modality for conducting this decision-making task, it suggests that leaders may experience similar declines in interactivity, high-quality communication, trust and team performance when text is the chief means of communicating.

Other modalities, ones that provide a richer communication environment, facilitate the transmission and processing of complex information. Though leaner as a medium, the audio modality was favorably regarded by users. The finding that satisfaction with task discussions was greatest under the combination

of audio and low task load indicates that the audio modality's benefits are greatest when it is not used for overly complex information transmission.

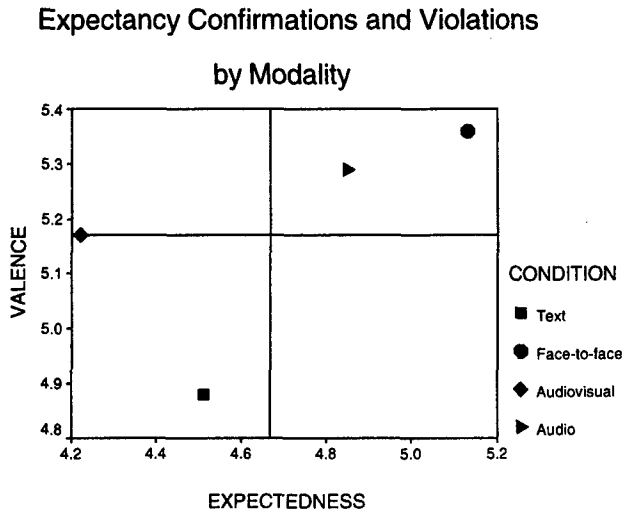


Figure 10. Expectancy Confirmations and Violations by Modality.

Experiment 5: Effects of Synchronicity and Information Validity as Task Load

The next investigation was intended to replicate previous investigations examining information complexity as the variant of task load and synchronicity of the communication medium.

Hypotheses. It will be recalled that synchronicity refers to the timing of message exchange such that interactions occurring in real time are considered synchronous, whereas those that entail some delay between message transmissions are considered asynchronous. Instant messaging, chat rooms, and FtF interaction are different forms of synchronous communication. Email and electronic message boards are forms of asynchronous communication. When participants simultaneously communicate with one another and engage several communication processes (e.g., sense-making, message production, message comprehension, turn taking management, and argumentation formation), they jointly construct the conversation, regarding themselves and teammates as integral entities in the exchange. They perceive that they have mutual concerns and common understanding of the issues under discussion. The joint ongoing interaction and mutual understanding may encourage team members to develop positive relationships and view each other's communication in a favorable light, in other words, to view other team members as trustworthy and credible. Synchronicity may be one way to offset drawbacks of text communication. We therefore tested the hypothesis that *synchronous text interaction produces more perceived involvement, mutuality, and similarity than asynchronous text interaction.*

Just as our previous experiments had shown that the presence of faulty and misleading information is "detected" by group members, we again tested the hypothesis that *presence of intentionally introduced information complexity (in the form of deceptive information) produces less perceived involvement and mutuality among team members than absence of same.*

Burgoon, Stoner, Bonito, and Dunbar (2003) had supported the hypothesis that involvement and mutuality measures were positively correlated with trust and truth estimates. The current experiment was expanded to

test the same hypothesis but with additional social judgments: *Greater interactivity is associated with more trust and other facets of credibility.*

Finally, circumstances that facilitate interactivity and team performance when members are engaged in cooperative, good-faith communication may be detrimental when faulty information and ulterior motives are present. A high level of interactivity may foster truth bias and interfere with message receivers' ability to detect invalid information. Alternatively, a high level of interactivity may reduce the time and opportunities for deceivers to monitor and modify their exchanges accordingly, thus increasing team members' ability to detect invalid information more accurately. A low level of interactivity may facilitate thoughtful deliberation and improve the quality of decision-making. However, it may also give deceivers enough time to reflect upon the current situation and modify their exchange accordingly, thus making deception detection more difficult. Several studies have indicated that distributed work produces weaker interpersonal relationships and less trust than does face-to-face work. Paradoxically, less trust and weaker relationships may cause potential targets of deception to become more suspicious and thus to increase their accuracy in detecting fallacious or faulty information.

Asynchronous media may affect information-processing in the same way. Group members working asynchronously exhibit less mutuality, pleasantness, and involvement than those working under a comparable synchronous format and thus may be less susceptible to a truth bias than those interacting synchronously. Conversely, greater involvement, mutuality, and pleasantness may foster trust and truth bias, thereby decreasing detection of invalid information and resulting in poorer decision-making. This reasoning formed the basis for the final hypothesis: *Higher interactivity fosters higher decision quality when there is no reason to suspect invalid information, deception, or ulterior motives, but impairs decision quality when deceit and invalid information are introduced.*

Sample and Method. Participants (N = 126) were undergraduate students enrolled in a business course at the University of Arizona who received extra class credit for participating in a study of how people conduct decision-making tasks under different communication formats. The design was a 2 (task load) x 2 (synchronicity) factorial design, with all participants randomly paired to form two-person teams, assigned to the role of Person A or Person B, and assigned to one of the four experimental conditions. The task was the Desert Survival Problem. Those Persons A asked to introduce faulty information received the same instructions as in Experiment 3. In the synchronous mode, participants discussed the task by using Microsoft Netmeeting text chat from geographically separated computer stations. The task usually took 50 – 80 minutes to finish. In the asynchronous mode, participants discussed the task by using an electronic message board system developed by CMI. After completing initial rankings, team members logged into the message board system, posted their initial rankings and some rationale for their ranking for their partners to review, then waited for partner responses. They were permitted to log into the message board system anytime, anyplace as long as they had Internet access, with the constraint that they needed to complete their discussions with their partners and arrive at final rankings within four and a half days.

Results and Implications. Consistent with H1, synchronous participants felt their partners were more involved and established more mutuality in their communication than did asynchronous team members, and consistent with H3, greater involvement, mutuality, and similarity were associated with being perceived as more credible and persuasive. Synchronicity also affected socially oriented credibility judgments directly. Synchronous teams viewed one another as more trustworthy and composed than asynchronous teams. These results indicate that one of the best ways to foster trust and credibility is to adopt real-time forms of communication. Delayed communication has the effect of attenuating involvement, mutuality and trust. Asynchronous communication also adversely affected changes in decision-making. Thus, synchronous communication proved to be the most beneficial on all fronts.

H2, that presence of faulty information dampens interactivity, was not supported. Deceptive team members were able to establish as much involvement and mutuality as nondeceptive ones. Similarly, presence of deception did not erode trust, and deceivers actually came across as more composed and sociable than truthtellers. Thus, they were able to present themselves in a favorable light. And, they undermined decision-making. Teams with invalid information did make poorer decisions. Some of this effect was attributable to interactivity. When deception was not present, team members who felt similar to their partners changed more toward the best decision; when deception was present, involvement tended to inhibit change, suggesting that greater engagement with deceivers enabled deceivers to deter partners from changing toward the best decision.

Experiments 6, 7, and 8: Effects of Modality and Information Validity as Task Load

The next three experiments each utilized a C3ISR (Command, Control, Communication, Intelligence, Surveillance, Reconnaissance) game. The first, SCUDHunt (Experiment 6), was originally developed by CNA as part of an experiment for Defense Advanced Research Projects Agency (Perla et al., 2000). The game is an online, turn-based strategy game originally designed to examine shared awareness in distributed groups. The object of the game is for a four-person team, each with different search capabilities, to find three SCUD launchers hidden on a game board with a predefined number of turns. As we became more familiar with the use of this form of distributed gaming and experimentation, we began to recognize limitations in SCUDHunt's design. We next developed an original game called BunkerBuster (Experiment 7). BunkerBuster simplified some of the complexity found in SCUDHunt to allow easier analysis of results, improved collection of participant data, changed the design so that all players interacted with the software in an identical manner, and minimized differences in game probabilities and asset differences to increase validity. Because of BunkerBuster's close ties to the design of SCUDHunt, the expandability and long-term usefulness of BunkerBuster was limited and resulted in development of StrikeCOM for Experiment 8.

StrikeCOM is a multi-player networked computer game entirely designed and built by the Center for the Management of Information at the University of Arizona. The object of StrikeCOM is for a team of players, each controlling different information assets, to search and destroy enemy strongholds. After multiple turns searching the grid and sharing their respective information returns from their assets, the team develops a unified strike plan to eliminate suspected weapons caches. The game capable of supporting any number of players using any number of information assets (e.g., Satellite, Spy, UAV) searching a game board of any definable size for any number of targets and target types that the researcher chooses to define. Players must coordinate their team strategy by communicating through one or more communication media. Players communicate through an optional integrated chat client or through external communications media. The players coordinate the placement of their assets and share information about the results produced by their assets after each turn. Once all of the players have submitted a search plan, aggregate and individual results can be returned to each player and the entire team. Because some assets return unreliable results, the team must communicate their individual results to interpret the aggregate board. At the conclusion of the final turn, each of the players must submit a strike plan indicating the target nominations (grid squares) based on their understanding of the previous turn's search results. Upon completion of the game, scores are calculated for each player and team based on the number of correct target detections compared to the total number of squares destroyed. A perfect score results from identifying all targets correctly without incorrectly identifying any squares.

Hypotheses. In addition to testing the same hypotheses as previously as regards introduction of invalid information, we considered that the nature of task itself and the expansions of team sizes to 3 or 4 had increased the overall complexity level, which might place more of a premium on having multiple modalities available to coordinate the task, obtain feedback and secure mutual understanding. We also considered the possibility of greater modalities giving deceivers more "resources" with which to manipulate team members and more avenues of feedback that would lead them to adapt their communication to best

advantage. Additionally, we were interested in how different combinations of leadership and information reliability affect team performance under different modalities. In any organization that uses distributed workgroups, it is not always immediately known if the group leader has more important or reliable information than subordinates. Distributed work makes it more difficult to share information among team members and thus develop situational awareness. Using our group-based, computerized, military intelligence exercise (StrikeCom), we investigated how the availability of a leader and the availability of reliable, task-specific information affect group performance. We modified both the presence of a leader and the presence of reliable information to test how important each are to the performance of a distributed group.

We reasoned that any team with a leader would perform better than teams without a leader, even if the team possessed the task information. This is because teams with a leader should coordinate information better than teams without leaders. We designated high-status individuals to act as leaders in our teams. We believed that the experience and the status of these individuals in conjunction with our designation of them as the team leader would lead to higher team performance than groups where similar individuals are present but not designated as team leaders. Thus we hypothesized that *teams with a leader outperform teams without a leader.* Similarly, based on the well-recognized importance of valid information to a team's performance, we provided additional task-specific information that aided in the successful completion of the game. Expecting teams with this information to have a greater success rate at the game than teams that did not know all of the details of the situation, we hypothesized that *teams with reliable, task-specific information outperform teams without reliable information.*

We also reasoned that a distributed group with a leader possessing reliable information that aids in the completion of a task should perform better than a team with a leader without the task-specific information. When the leader has information important to the task, we expected the teams to perform above all others because the leader would have greater ability to coordinate the distribution of information to the team. Thus, we hypothesized that *teams with both a leader and reliable information will outperform teams with any other combination of leader and reliable information* and that possession of the reliable information by the leader would be the strongest of all possible combinations in producing successful team performance.

Sample and Method. We conducted multiple experiments examining the effects of the presence of a leader and of reliable task-specific information have on the performance of a team playing a customized computer game. Initially, four-person teams played a networked, turn-based strategy game where each participant played a different role and controlled different information. Players communicated with each other through a simple, online text-chat application, audio, or face-to-face and were unaware of who the other members of their team were or where they were located. Neither the presence of a leader nor the knowledge of role importance/information reliability was necessary to satisfactorily complete the game. We chose to assign one of the participants as a leader for some of the conditions, and we provided information concerning the reliability of the information one of the players possessed in some of the conditions.

The first experiment used SCUDHunt. Each SCUDHunt team consisted of four players working together to find 3 Scud launchers that were hidden on a 5 X 5 grid game board. Players coordinated strategy and the placement of the assets and shared information about the results returned by their assets. Each turn, every player submitted a search plan for their assets. Once all of the players had submitted a search plan, aggregate results for the entire team were returned to each player and detailed results for each asset were returned to the appropriate individuals. Since some assets return unreliable assets, the team needed to communicate their individual results to interpret the aggregate board. At the conclusion of the fifth and final turn, each player submitted a strike plan consisting of target nominations (grid squares) based on their best estimate of the situation. In the original version of the game, teams formulated strike plans at the end of every turn. We modified the game so that there was only one strike plan at the end of the game. After five turns, the game ended and team success was calculated based on the number of correct SCUD launcher

detections per team member compared to the total number of squares destroyed by the team. A perfect score resulted from detecting three SCUDs by destroying three squares.

Similar methods were employed with the BunkerBuster and StrikeCOM experiments. However, we reduced group size from four to three. For StrikeCOM, we also created a single asset that was capable of searching five cells each turn for five turns on a twenty-five square board. This means the asset could search the entire game board during a single game. If the subjects were told that the asset returned perfect information, they could make the intuitive leap to the strategy of searching the entire board with the reliable asset and make their final decision based on that one asset's information. In the conditions where subjects did not know that the asset returned perfect information, they could still reach the same conclusion as teams who knew the asset was reliable, but were unlikely to do so in the absence of that explicit information. Team members were informed that knowledge of an asset's importance or reliability was unnecessary to satisfactorily complete the game.

In StrikeCOM, we created five conditions representing combinations of leadership and information reliability. In the control condition, there were no manipulations, In the designated leadership condition, we used status to create leadership but provided no information about the reliability of intelligence assets. In a third condition, teams were given knowledge of which asset was the most reliable but did not have an assigned leader. In the fourth condition, the leader controlled the reliable asset. In the fifth condition, the reliable asset was controlled by a subordinate. These combinations made it possible to parse out the respective effects of leadership, knowledge of information reliability, and their combination. A sixth condition manipulated task load in the form of faulty information. In this condition, one player in each team was instructed to work against the team and to deceive team members by interjecting false or misleading information. The deceptive instructions thus created the kind of task load present in prior experiments.

Games were conducted under one of three modalities: FtF, text, or audio. In the FtF condition, all team members sat at a segmented circular table with a small notebook computer in front of them. Computers were used to deliver instructions, to conduct a practice game, to complete their searches and submit a strike plan, and to answer the post-game survey. Discussion of search strategies and the final strike plan was all oral, and team members had unobstructed views of one another. In the text condition, two teams completed the game at the same time. Team members were distributed across two different rooms, with dividers between the table segments to prevent participants from seeing those seated in adjacent stations and from determining who else was part of their team. All communication took place via chat using a special chat screen that logged all communications. In the audio condition, team members were again distributed and equipped with sound-cancelling headphones that recorded their interactions and blocked sounds from adjacent stations. At the end of the game, participants completed an online survey concerning leadership roles within the team and team members' assessments of their teammates' performance and credibility.

Results and Implications. ScudHunt results were somewhat equivocal and potentially attributable to game artifacts. BunkerBuster results showed significant modality and task load effects as well as interactions between the two. First, involvement was lowest in the text condition, and equal in both the FtF and auditory conditions. Mutuality was also lowest under text and highest, especially in terms of openness, under audio. Second, task load in the form of deceptive information adversely affected interactivity. Those in groups with deceptive information had less involvement and similarity than those without introduced deception.

Third, other task communication was also affected: nine other dimensions of communication that were measured showed modality effects, especially in terms of spontaneity of interaction and amount of analysis and feedback that was exchanged. The audio mode had the best quality communication, whereas the text mode had the worst. Fourth, modality interacted with task load on several measures. Positivity and composure were all highest under FtF and/or audio communication and lowest in text, particularly under deception. Together with the interactivity results, these results provide strong demonstration to leaders of the adverse impacts of high task load on communication processes and involvement in the task.

One exception was task focus, which showed the opposite pattern. Whereas with low load (truth), team members reduced attention to team relationships and focused more to the task under FtF and audio than text, under high load (deception), task focus was higher with text than FtF and audio. In other words, the combination of deception and text impaired communication on many dimensions except task focus, which was actually highest under deceptive text. Conceivably (and consistent with our other findings), teams recognized when something was amiss with the information being introduced by the deceiver and this caused greater attention to the task. This provides some meager indication that teams are able to detect faulty information when the communication modality is the leanest, i.e., lacks all the other accompanying nonverbal modalities.

Fifth, task load impaired team performance. Its impact was most severe in the audio condition. Finally, load interacted with modality such that teams interacting FtF or via audio were least capable of overcoming the presence of invalid information when it was present (see Figure 11). This result is contrary to previous findings that team members were best able to detect deceptive information in the audio modality and least successful in the text mode. We conjecture that the increased group size elevated task load in the audio and FtF conditions because more coordination was needed, and information from nonverbal channels also had to be processed. Comparatively, the cognitive demands on those in the text mode were fewer, in part because text messages were briefer and in part because team members did not need to make sense of incoming nonverbal information nor to manage their own nonverbal messages. Further, the recoverability of text messages meant that one could review what was said, which might also meant that deceivers were less explicit in trying to mislead the team and therefore less successful.

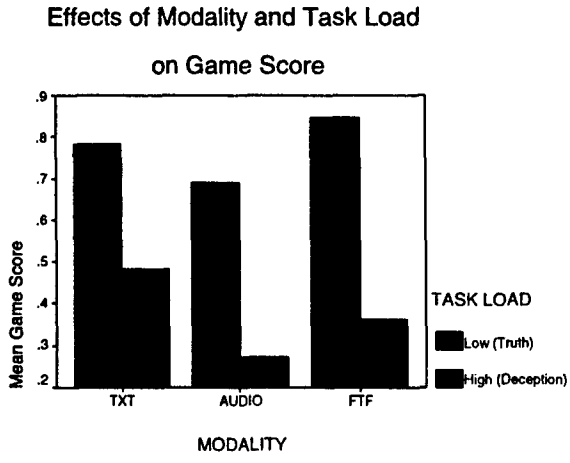


Figure 11. Effects of Modality and Task Load on Team Performance

Overall, then, richer modalities did facilitate interactivity and other facets of communication, as predicted. Text was least desirable for achieving involvement, mutuality, and high-quality task-related communication. However, greater interactivity was accompanied by better team performance only in the FtF condition and under low load. When task load was high, both the FtF and audio conditions showed a significant decrement in team performance; comparatively, the text condition showed less loss, albeit still quite a difference from the low-load text condition. This counterpoint to previous results implies that under the right circumstances, text-based communication may have some merit.

StrikeCom results echoed those for BunkerBuster in showing that modality affected interactivity. The FtF condition produced more involvement and mutuality than the two distributed conditions, and the audio condition produced more interactivity than the text condition (see Figure 12).

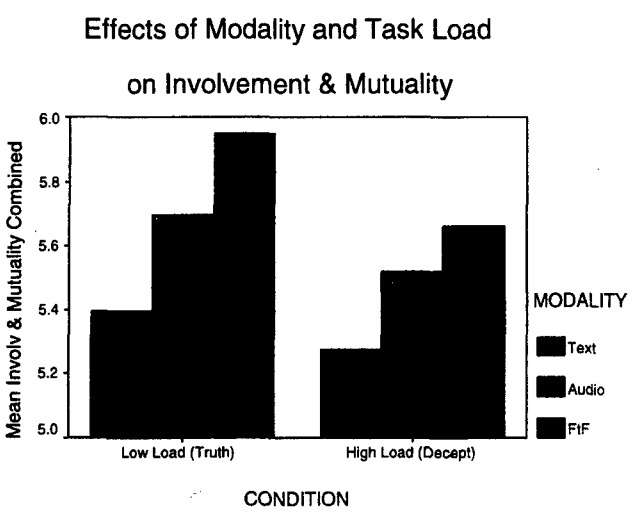


Figure 12. Effects of Modality and Task Load on Interactivity Measures.

Modality did not affect trust, only task load did. As with previous investigations, participants felt less trust for the source of faulty information. This could be interpreted as task load generally impairing trust or as further demonstration of team members' ability to pick up on the presence of invalid information. We speculate that it is a combination of both, given that task load had undesirable effects on communication processes that are themselves strongly associated with trust and credibility.

Leadership and knowledge of reliable information both affected the outcome of the games, and the effects were not altered by modality. Teams with emergent or designated leaders performed better than those teams without leaders. Teams with leaders had better total game scores and fewer misses. Similarly, those who had a good understanding of their situation performed better than those with an incomplete understanding of their situation. Although teams without explicit knowledge of the reliable asset had the same potential to search the entire grid and achieve maximum knowledge about locations of bombs, the communication logs revealed that teams failed to discern this and had a more difficult time formulating their search strategy, or formed a more random search strategy, at the beginning of the game. Consequently, none of the teams lacking explicit knowledge of reliable information received a perfect score.

One caveat to drawing firm conclusions from these results is that the a post-experiment survey indicated that there was only scattered understanding not all assets were equally reliable and that the Unmanned Air Vehicle was the most reliable. This was either a problem with our survey questions, our instructions, or the subjects. There was no meaningful correlation between conditions with reliable information and players' understanding of asset reliability.

We also observed that high status individuals were likely to talk considerably more that other team members in the conditions where they were designated as leader. However, only when players thought the leader had reliable info were they listened to. Because students' experiences with gaming differed considerably, as did motivation to immerse themselves in the game, we replicated the experiment with AFROTC students, described next.

Experiment 9: Effects of Information Validity, Modality, and Induced Distrust as Task Load

Hypotheses. This research was undertaken as a thesis by Captain Michael Hass of the Air Force Institute of Technology. Like its predecessors, the objective was to determine if cognitive demands in the form of invalid information alter the impact of communication modality on interactivity and team performance. Given the complexities of the StrikeCOM simulation, it was expected that modality itself would also add to task load. Specifically, it was hypothesized that text communication would be perceived as more difficult than FtF communication. Another factor introduced into the experiment was induced distrust (warnings of player deception). It was hypothesized that induced distrust would mitigate the effects of invalid information, improve detection accuracy and consequently, team performance.

Method. Cadets (N = 108) from the University of Arizona Air Force ROTC Detachment 20 were grouped into teams of three, given similar instructions but different goals, and asked to play a version of StrikeCOM that mimicked the intelligence gathering needed to develop an air tasking order and subsequent air strike on three military targets. Cadets were assigned a role (deceiver, suspicious, naïve) and to one of three conditions: real-time text chat without deception (the control group), real-time text chat with deception, or FtF communication with deception. Deceivers were instructed to ensure that targets were not found or destroyed. They were expected to mislead the other players by providing false results or suggesting detracting courses of action. The role of the naïve player was to play the game as best they could. They were unaware that one of the other players had a different goal. The goal of the suspicious player was also to achieve the highest possible score, but they were aware that one of the other players might have a conflicting goal. The suspicious player did not know which of the other players was the deceiver and, in some cases, did try to find out.

Results and Implications. Team members rated the task as more difficult when deception was present than absent and when conducted via text than FtF. In other words, deception did elevate task load for both text and FtF interaction, and text also elevated it relative to FtF. Team performance suffered under both deception conditions. Team members were more suspicious and motivated to detect deceit when deception was actually present, indicating that they were picking up on some leaked indicators of deceit. Suspicion and motivation were also higher in the text than the FtF mode, something found previously and ascribed to a weaker truth bias under text than FtF interaction. Those in the text modality who were induced to distrust others perceived more deceit than those in the other conditions and also rated the task as more difficult. Although one would hope that heightened awareness of the possibility of invalid information would confer some advantages in terms of team performance, results from the preceding and other investigations imply that it might not. In this investigation, suspicion was inversely correlated with game score, i.e., where suspicion was higher, performance was lower. This implies that greater suspicion did not aid performance.

Experiment 10: Maintaining Awareness in Distributed Team Collaborations

A tenth investigation pursued ways leadership can mitigate distrust and improve team performance by examining communication awareness. Problems attributed to a lack of information about others' activities have led researchers and designers of computer-supported systems to develop so-called awareness mechanisms in distributed work groups (Dourish & Bellotti, 1992; Dourish & Bly, 1992; Fussell, Kraut, Lerch, Scherlis, & Cadiz, 1998; Gutwin et al., 1996; Steinfield, Jang, & Pfaff, 1999). Dourish and Bellotti (1992) define awareness as an "*understanding of the activities of others*, which provides a *context for your own activity*" (p.107, emphasis in original). Awareness reduces the effort needed to coordinate tasks and resources by providing a context in which to interpret utterances and to anticipate others' actions (Gutwin, et al., 1996).

Interactivity can be understood within the context of awareness. Messages that are exchanged may be directed to achieving four types of awareness: activity (knowing what others are doing), availability (knowing when others are available to meet or talk), process awareness (knowing how various pieces of the process fit into the big picture), and social awareness (having the individuating information to know each member's social situation). Effective leaders promote these forms of awareness, along with participant involvement and mutuality, by structuring tasks and communication modalities to achieve them and by engaging in behaviors that signal trust, respect, and concern for others. This field experiment sought to understand how distributed work teams sustain or increase awareness of other group members, and how awareness communications are related to members' efforts to coordinate their own work with the work of others. Awareness was manipulated by informing the team members about how the work was progressing, who was doing his or her part, and who was otherwise moving the team toward product completion (e.g., Barge, 1994). The study also was meant to discover how efforts to sustain awareness and leadership behavior are related to team success.

Hypotheses. Based on the previous literature, we expected that interaction to support awareness of others, the task, and the group's progress--in short, "group awareness"--should lead groups to be more successful (Cannon-Bowers, Salas, & Converse, 1993). We therefore hypothesized that *distributed project teams that communicate to sustain or increase group awareness of one another and their work collaboration will perform better than teams that do not.*

One way to achieve greater awareness is to communicate on a regular, and perhaps daily, basis. A second hypothesis tested the anticipated benefit of frequent interaction: *The more frequent the daily interactions of distributed project team members, the better the team will perform.*

In this study, two types of leadership behavior could be examined to capture the two leadership concepts, initiating structure and awareness. Leaders who initiate task structure in short-term project teams may need to put pressure on group members to focus on the task objectives and complete the project on time (Yukl, 1994). We defined "*pressure initiations*" as occurring when someone (a leader or member) stressed task objectives and meeting team goals. Effective leaders must also be able to monitor the progress of others and maintain connections with, and awareness of, who is doing their part in order to anticipate problems and integrate members' contributions (Hackman & Morris, 1975). In this study, "*other awareness*" meant someone took action to find out what the other members of the team were doing, and to assess how others were doing. Our third hypothesis stated that *project leaders who initiate pressure to complete the task on time will perform better than leaders who do not.*

Method. Graduate and undergraduate business students (N = 66) in two geographically distant U.S. universities participated in a four-week project using a web-based computer conferencing system and email to perform their project, writing a short consensus policy document. There were 15 students (2 graduates and 13 undergraduates) from a northeast university (NU) and 51 students (15 graduates and 36 undergraduates) from a southwest university (SU). Students were instructed to select one student from NU on the team and one graduate student as project leader. All projects were completed in 4 weeks, with interdependent tasks (so that communication and coordination were required to achieve team objectives), and whose members were restricted to some form of computer-mediated communication. To enable fair participation across the universities, the project started and stopped on the same dates, and students were given the same project instructions, requirements and deadlines.

To measure the amount of team interaction over the course of the project, computer-generated messages for each team were counted for each day, separating out messages from leaders and messages from team members, and messages that initiated topics as compared with replies to these messages. A message could contain multiple questions or statements that might be coded as creating, reinforcing, or increasing group awareness. An awareness initiation was defined as new invitations for others involved to respond.

Initiations could be questions (e.g., "How was your weekend?") or statements (e.g., "Please send me your comments."). They could be implicit requests for attention (e.g., "I just set up my distribution list. I think it's working.") or explicit requests for information about others ("Are you working today?"). The most important criterion for coding a question or statement as an initiation was that a response had to be possible or plausible. In the analysis presented in this chapter, only leader and member awareness initiations are included, and not responses to them. Since multiple responses to one initiation were possible, examining initiations only provides a cleaner analysis of the data.

The coding process used short phrases derived from the team members' own language (Glaser & Strauss, 1967). Data were sorted into four categories of group awareness messages (self awareness, availability awareness, process awareness, and social awareness) and two categories of leader awareness messages (awareness of others and initiating pressure).

Results and Implications. This study began with the idea that creating and maintaining group awareness in distributed collaboration is necessary for effective and timely coordination of work in short-term project teams. Although frequently initiating awareness messages to the team is effortful and time-consuming, the result, according to the evidence in this study, is improved team performance. Teams in which members sent messages indicating where they were and what they were doing, and messages in which they queried others of their whereabouts, availability, and progress, performed better than teams that did not. Teams that interacted frequently were more successful than teams that missed many days online. We found that low-performing teams were absent significantly more often than were high performing teams. The data also showed that early team interactions contributed most to successful team performance. Teams in which members sent information about themselves, thereby personalizing identities sooner, or who inquired after others early performed better than teams in which members did not. Teams learned enough social information about each other early in the process to know each others' preferences, work styles, schedules and habits. This knowledge then could be used to help them become even more effective in working with one another, particularly during the final push to conclude the project. In the early days of the project, high-performing team members established successful interaction styles that were continually reinforced (Gersick & Hackman, 1990). They put pressure on each other to move quickly and everyone submitted to that pressure. High-performing teams found out each others' schedules, checked up on each others' progress, and maintained almost real-time synchronous interaction as the project neared completion.

A process such as the one we observed seems to be iterative. As the level of awareness and peer-monitoring in a group increase, the intentions and capabilities of the group are uncovered (Powell, 1996). Positive and mutually reinforcing cycles of initiations and responses among interdependent team members play a fundamental role in the development of collective trust and cooperation (Iacono & Weisband, 1997). Members are able to anticipate future behavior, and when that behavior is viewed positively, trust develops (Jones & George, 1998). Understanding the relationship of awareness and trust in distributed work groups may be an important area for future research.

One goal of this study was to understand the role of leadership in distributed work groups. Effective project leaders were expected to initiate task demands and to show consideration of others early to set the stage for successful future interaction and performance. The data support this idea. Project leaders contributed to team performance when they initiated pressure and awareness of others. Pressure was especially effective early in the project. When project leaders began to initiate pressure in the second half of the project, team performance declined.

In this study, all teams had assigned leaders, but assignment as leader is in part a context from which leadership may or may not emerge (Meindl, 1993). According to Meindl (1993), "leadership emerges in the minds of followers" (p.99). Clearly, some teams in this study did not have effective leaders, and this became clear in how team members responded to leader requests. For example, some project leaders

initiated awareness in a way that motivated team members to stay in constant touch with each other whereas others frustrated the members.

To evaluate perceptions of leadership across all the teams, leader evaluations were collected from members after they turned in their projects (but before they received their grades). Six questions, based on 5-point scales, where 1=not at all and 5=almost always, asked members whether leaders: 1) "involved me in problem solving and decision making activities", 2) "motivated and encouraged me", 3) "treated me fairly", 4) "led by example", 5) "demonstrated a definite sense of direction and purpose", and 6) whether they would choose to work with this project leader again (yes/no). Members who later received excellent ratings for their projects tended to evaluate their leaders higher (M=4.0) than did members who later received relatively lower ratings for their projects (M=3.6). Leader evaluations were also significantly correlated with the leader's early pressure initiations (r=.55, p<.05), but not with the leader's initiation of other awareness messages. Possibly, a strong focus on the task deadlines early in the process allowed the leader to emerge as such in the minds of team members (Meindl, 1993). They were able to effectively develop the interaction patterns necessary to move the team forward quickly (Zacarro et al., 1995).

Experiment 11: Leadership, Modality, and Performance in Distributed Teams

To further examine how to manage leadership at a distance, the next investigation was a longitudinal study of distributed teams. Of interest was whether prior interaction improved distributed team performance. We also wanted to know whether anyone can be a project leader in distributed teams. That is, we wanted to know whether the role is more important than leader characteristics.

Hypotheses. A week prior to the start of the team project, distributed teams either convened face-to-face, met online, or did not meet at all. We hypothesized that *(a) teams that meet and interact prior to the group project perform better than teams that do not; (b) teams that meet and interact on the web perform better than those that meet and interact FtF; (c) teams with self-selected leaders perform better than those with randomly assigned leaders; and (d) distributed teams that communicate to sustain or increase group awareness of one another and their work perform better than teams that do not.*

Method. Graduate and undergraduate business students in two sections of one class at one university participated in a four-week project. There were 43 students in section 1 (86% undergrad; 70% male) and 51 students in section 2 (78% undergrad; 67% males) of the class. Student teams were assigned by the experimenter so that two members of the team were in one section and two members were in the other section of the class. One week prior to meeting to work on the distributed project, students participated in a pre-task activity to allow students to get to know each other prior to working on the project. The pre-task consisted of get-together activities, including trivial pursuit questions and some GRE questions. Students were divided into three groups: 8 teams met face-to-face; 8 teams met on the web conferencing system they would use later in the project, and 7 teams did not meet but worked on the pre-task individually and then handed answers in to the professor who distributed them to the other members of the team. A questionnaire was then distributed to students at the end of the first week.

Before the project began, team leaders were selected in two ways: (1) members chose a team leader (team-selected leader), or (2) a leader was randomly assigned (randomly-assigned leader). Students were then instructed to begin the project. All projects were completed in 3 weeks. Tasks were interdependent (so that communication and coordination were required to achieve team objectives), and communication was restricted to some form of computer-mediated communication. Email messages of all 23 teams were coded.

Results and Implications. Teams with team-selected leaders performed better (M=91.6) than teams with randomly-assigned leaders (M=87.8). An interaction effect of leader selection and pre-project condition revealed that team-selected leaders performed better when teams first met online. This could be due to the

fact that the web was the medium that the teams would be working with, or it could be that the leaner medium of the web allowed members to focus on appropriate social and task cues (Weisband & Atwater, 1999). It suggests that distributed teams were able to pick a good leader when they met on the medium in which they were going to conduct their joint work. We also found that leader assignment moderated team awareness, such that teams that selected their leaders used more awareness mechanisms than teams with randomly-assigned leaders. Although interactivity was not measured directly, these results signal that one way to maintain high involvement and mutuality is to maintain regular and consistent communication among distributed team members. Awareness mechanisms are thus one means of compensating for the difficulties introduced by distance and computer mediation.

SUMMARY CONCLUSIONS AND IMPLICATIONS

Conclusions

Whether work teams that communicate through new computer technologies fare better or worse than teams that meet face-to-face meetings depends on what the task is and what the team's objectives are. Our series of studies focusing primarily on voice-only, audio-visual, and text interfaces, and on several collaborative tasks, found that the degree of interactivity that team members achieve affects team trust and performance, irrespective of the type or difficulty of the task. Characteristics of interactivity include how connected participants feel toward each other, how involved they are, and the extent to which they perceive each other as having the same goals. Collaborations that are perceived as highly interactive reflect favorably upon perceptions of the participants and are associated with other positive communication qualities such as high quantity of information, efficiency, critical analysis, and smooth, relaxed and pleasant interaction. These qualities in turn contribute to strong team performance. Some technologies make high interactivity more likely than others and result in higher team trust and performance. For example, same-time voice communication creates mutual feelings of connection, understanding, and involvement; leads to richer and more fruitful discussions, builds trust, and results in better decision-making. More cognitively challenging tasks may benefit from the availability of visual as well as auditory channels to clarify meanings, signal understanding, and exchange feedback. But even interfaces that are less "interactive" (e.g., email) can still be perceived as fairly interactive, under the right conditions and with the right guidance from leaders. Not all tasks profit from interactivity, especially when longer, more thoughtful deliberation is needed, or potentially invalid information is being shared that needs greater scrutiny. In these cases, less interactivity—greater detachment and sense of separation—will lower trust but may result in better decision-making. Real-time technologies such as instant messaging, cell phones and voice communication may actually create mindless information processing and hasty decisions as compared to older technologies such as different-time bulletin boards and text exchanges.

Our research did reveal, somewhat unexpectedly, that the degree of mental or physical effort required for a task has variable effects on communication, trust and performance. People are often able to compensate for task difficulties, and, for some aspects of communication, moderate difficulty is preferable to low difficulty, probably because it keeps people more alert and caught up in the task. But some interfaces, such as text, which requires typing rather than speaking, require more mental effort to use and therefore may be best matched with less "taxing" tasks. With difficult tasks such as comprehending more complex information, text-based interfaces also seem less interactive, making them inadvisable choices if trust and group morale are at stake. Face-to-face and visual communication, however, are not the best choices if the task entails recognizing and assessing invalid information.

Implications for Military Leadership, Trust and Performance

Because this research was funded by the United States Army, there is considerable interest in how these results are informative for military applications. The answer depends to some extent on which outcomes are desirable. Imagine that one wanted incoming information to be monitored for its veracity—in such cases, audio communication seems to accomplish this, as does bulletin board style communication. On the other hand, if one desired simple information exchange (e.g., orders or commands that should not be questioned), then chat-style text might fit the bill. In the end, the complexity of communication is affected by the technology that teams use. It is critical that technologies be fitted to desired aims and outcomes and that leaders either select appropriate technologies or take measures to offset any downside risks of using a given technology.

Effectively coordinating behavior and activities among interdependent people at a distance is one of the major challenges of leadership. The need to continuously communicate is essential for sharing information and knowledge of group and individual activities related to the task, for informing others about work progress, and for anticipating others' needs or actions to achieve successful outcomes (DeSanctis, Staudenmayer & Wong, 1999; Rasker, Post, & Schraagen, 2000; Sheppard & Sherman, 1998).

Uncertainty is particularly high in geographically distributed groups. Because of delays in remote communication, feedback about others' behaviors is difficult to obtain (Kraut, Egido, & Galegher, 1990; Ruhleder & Jordan, 1999). With delayed feedback or inaccurate feedback, messages require a few iterations for clarification (Clark & Brennan, 1990). Some messages are long, making a response effortful and time consuming. When important information is lost, it can create the appearance of members acting independently or "hiding" their need for interdependence (DeSanctis et al., 1999). Hidden interdependence, in turn, can reduce coordination (Serfaty, Entin, & Johnston, 1998), trust in others, and commitment to group goals (Sheppard & Sherman, 1998).

In distributed groups, leaders and members need to actively monitor others' activities to keep informed about the work of the group and what other members of the group are doing (Gambetta, 1988). In face-to-face groups, feedback about what others are doing is immediate and can be accomplished passively. Group members, for instance, can glance over at another person to see if they are working or they can hear the sound of a particular machine and know what work is being done (Gutwin, Roseman, & Greenberg, 1996). In contrast, distributed groups can go long periods during which they have no information about their teammates' activities. They may have to rely entirely on the messages that appear on the computer screen to figure out what other members of the work group are doing. Informal leadership that emerges within a team, rather than formal leadership, may have the most influence on the resultant communication process and outcomes. Designated leaders are well-advised to monitor such interactions, to encourage frequent interactions among distributed team members, and to remain attentive to the degree of interactivity present in the team's communication so that intended objectives are met and unintended negative consequences are prevented.

What follows is a quick recap of the implications this program of research has supported with respect to leadership, trust, team-building and performance when using electronically mediated communication:

- Leaders may derive many benefits from using cell phone and teleconferencing forms of communication, rather than broader bandwidth modalities.
- Expect process and performance losses if time pressure becomes excessive.
- Time-pressure needs to be kept in a moderate range.

- High-pressure circumstances may require the addition of visual cues to coordinate task performance and gain feedback.

- Interactivity is key to achieving team morale and cohesiveness. Mediated forms of communication are worse at fostering it than FtF interactions; text is the worst.

- Where skepticism is wanted, accurate detection of faulty information is best achieved not by text, but by audio and perhaps AV modalities. Communication processes "register" invalid information. – reductions in interactivity and trust may be symptomatic of faulty information or ulterior motives present in the team

- Strategies are needed to ensure that reductions in involvement and mutuality do not simply dampen alertness, careful evaluation of relevant information and commitment to the team.

- Complex information need not be experienced as overly taxing – Text remains the least desired means of communication.

- FtF and CISs that include nonverbal cues are best for eliciting interactivity.

- The benefits of audio communication may be limited to circumstances where information complexity is not overly high.

- Same-time communication is far preferable to delayed communication for generating involvement, mutuality, and credibility.

- Communicating in real-time can offset otherwise undesirable effects of text-based communication, however it can be easily manipulated by the unscrupulous.

- Richer modalities foster greater interactivity, high-quality communication and trust than text does, but higher interactivity may also be detrimental to team performance.

- When task load is elevated due to the presence of faulty information to be detected, the mos interactive modes are also the ones showing the greatest decrements in performance.

- The audio mode may be less desirable when task load is exacerbated by features such as size of the team or complexity of the task – under these circumstances, text communication may be easier to manage and also offers a permanent record that can be reviewed.

- The presence of invalid information may be recognized implicitly by team members, but its effects may be to damage team relationships, rather than to improve team performance.

- Leadership is extremely important to harness distrust when it surfaces and channel it toward better analysis of information, rather than let it sabotage team morale and engagement.

- Communication over distances and through text modes presents significant challenges. Effective leaders must continually monitor team communication for erosion in quality communication and for signs that questionable information is being exchanged.

- Leaders can mitigate some of the disadvantages of communicating at a distance by maintaining group awareness through initiating pressure to keep on task and by showing awareness of individual identities.

- Pressure initiations are most effective when begun early – introducing them late in a decision-making process is counterproductive.

- Positive and mutually-reinforcing cycles of initiations and responses among interdependent team members will contribute greatly to collective trust and cooperation.

- Team selected leaders perform better than assigned leaders. Military leaders can gain some of the same benefits achieved by team-selected leaders, however, if they ensure regular and consistent communication among team members, and by initiating awareness messages that take note of where people are, what their activities and schedules are, and other individuating information.

Contributions to Basic Science

A major cause for concern in research on new communication and information technologies has been the stark lack of theoretical interest and development. Some years ago, researchers concluded that most discussions of technology were based on people's common sense extrapolations, as opposed to theory-driven empirical research, especially in the areas of the social consequences of technology. Much of the previous research has failed to establish any significant understanding of the phenomena beyond some modest empirical generalizations and causal observations. The current program of research offers a counterpoint to the anecdotal and "intuitive" base of so many claims about technology by offering both experimentally-tested findings and a theoretical model by which to account for the effects. Such an approach also helps avoid the conceptual fallacy of believing that by creating a new theory, moderator, or mediating variable, one has created new knowledge. CISs do not "obey" unique laws of communication or human performance; existing principles, embedded within the principle of interactivity, are sufficient to account for the impacts of new technologies, once terminological translations are made from old to new concepts and forms.

This program of research contributes to knowledge and theorizing in the domains of leadership, group performance, trust, and human communication. As well, it has direct implications for current organizational theories that address distributed "virtual" processes for accomplishing work. As work becomes more global and distributed, the whole nature of organizing will inevitably be modified. Such changes need to be guided by systematic empirical investigations rather than by anecdote and personal experience, which in many quarters form the primary source of "data." The theoretical principle framing our series of controlled experiments offers one coherent account for how new technologies utilized for distance communication impact communication patterns, trust, and leadership. The principle of interactivity proposes that the greater the degree of interactivity, the greater the trust and credibility. Where high trust is warranted, more interactivity should result in better performance. However, where skepticism and suspicion are warranted, such as when the task involves recognizing and deciphering invalid information or uncovering ulterior motives, greater interactivity may foster too much trust and result in poor performance. Degree of interactivity is therefore a key factor in predicting team trust and performance.

Our research program offers the richest explication in the scholarly literature of what constitutes interactivity and its possible effects. Original contributions include the focus on message exchange itself, and introduction of the qualities of involvement, mutuality, individuation, and coordination as primary markers of interactivity. Our assessment of related communication qualities also offers new ways to gauge whether a team will develop and maintain optimum levels of trust and performance. The use of both laboratory and field experiments, and the use of a variety of tasks and forms of task load also increase our ability to generalize this research to other contexts and to discover those conditions under which the general principle may not hold.

A final contribution is the development of new web-based task, StrikeCom, which can be used for testing various forms of task load, group composition, and deceit, among other research objectives. StrikeCom has the virtues of engaging participant interest, simulating the kinds of tasks Soldiers might confront, and having the flexibility to modify such features as different map overlays, availability of a common situational awareness space, grid size, number of players, number of information assets, and reliability of the information that is returned. This flexibility has been instrumental in using StrikeCOM for several different studies.

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